MISCELLANEOUS
LETTERS

7158

On Several SUBJECTS in
Philoſophy *and* Aſtronomy.

Wrote to the Learned
Dr. *Nicholſon*, late Archbiſhop of *Caſhell.*

VIZ.

I. An Account of the great variety of Plants, Shell-Stones, and many other Curioſities, in the Pariſh of *Magilligan*, in the County of *Londonderry* in *Ireland*; together with a curious Account of the forming the Land, being formerly under Sea.

II. On the Declenſion of the Level of the Sea.

III. On the *Aurora Borealis*, or Northern Light.

IV. On the *Iriſh* Bogs, Timber found under theſe Bogs, and ſeveral curious Remarks on the firſt Planting the World and *Ireland*, drawn from the Natural Hiſtory of ſuch Bogs and Timber.

V. On the General Tides in the *Atlantic* Ocean, by a New Hypotheſis, and that the Moon hath no Influence on the Tides.

VI. On the Cauſe of Gravity, and the Continuation of Motion, by a New and Curious Hypotheſis.

VII. On the Load-ſtone, that the Old Hypotheſes were Inſufficient, and a new one drawn from the Northern Light.

VIII. An Endeavour to clear Aſtronomy of the Incredible, by a new Syſtem of the World, wherein the Projectile Power, and Gravitating Principles of Sir *Iſaac Newton*, are proved to be not according to Nature, and Impoſſible; and that the Theory of the Moon is particularly very ill accounted for by Sir *Iſaac's* Principles; and New Principles, drawn from the Nature of Fluids, and a repelling Power in the Sun, and that the long Teleſcopes help to deceive us.

By ROBERT INNES, *A. M.*

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M.DCC.XXXII.

BRITISH MUSEUM

THE

PREFACE.

THE Occaſion of Writing theſe LETTERS was this: The late Archbiſhop of *Caſhell*, the Learned Dr. NICHOLSON, when Biſhop of *Derry*, had a Deſign (as was believed) to write the Natural Hiſtory of his Dioceſs; He ſpoke to his Clergy, and to me among the reſt, to make Obſervations on any thing that might further ſuch a Deſign. This put me upon writing the Firſt Letter; after which His Lordſhip did ſo much approve and encourage my Writing on other Subjects in *Natural Philoſophy*, that I ventured to write the following Diſſertations: Some of them were not finiſhed before he died; but being diffident of my own Abilities alone to venture on ſo great a Change in the preſent Philoſophy, I ſent theſe Letters to the College of *Dublin*, except the two laſt, which were not then finiſhed, to be Reviſed and Corrected; but after two Years I received them again, with only a Requeſt that I would ſend them to

the

the *Royal Society*, except that on the Tides, but without any Amendment or Objection againſt it. This was little Satisfaction to me, however I carefully Reviſed it, and made ſeveral Alterations in it.

I do believe I ſhall meet with Oppoſition to ſome of theſe Papers, and the great and deſerved Name of Sir *Iſaac Newton* may ruffle ſome People's Tempers, to ſee ſome of his Principles contradicted; and I muſt own, the Veneration I had for him, and the great Inequality of my Abilities to his, had almoſt ſtifled ſome of them: But then conſidering, that in Philoſophy, nothing hath ſtopped the Progreſs of it more than being too zealous for the Dictates of our Maſters; I ventured upon ſolving ſeveral Difficulties upon other Principles than was as yet thought upon. So that if I cannot ſatisfy every Man, yet I may ſtir up others to examine theſe Things better, and endeavour a more rational Solution of many Difficulties in Philoſophy, which hitherto have been very little to the Satisfaction of the Learned World.

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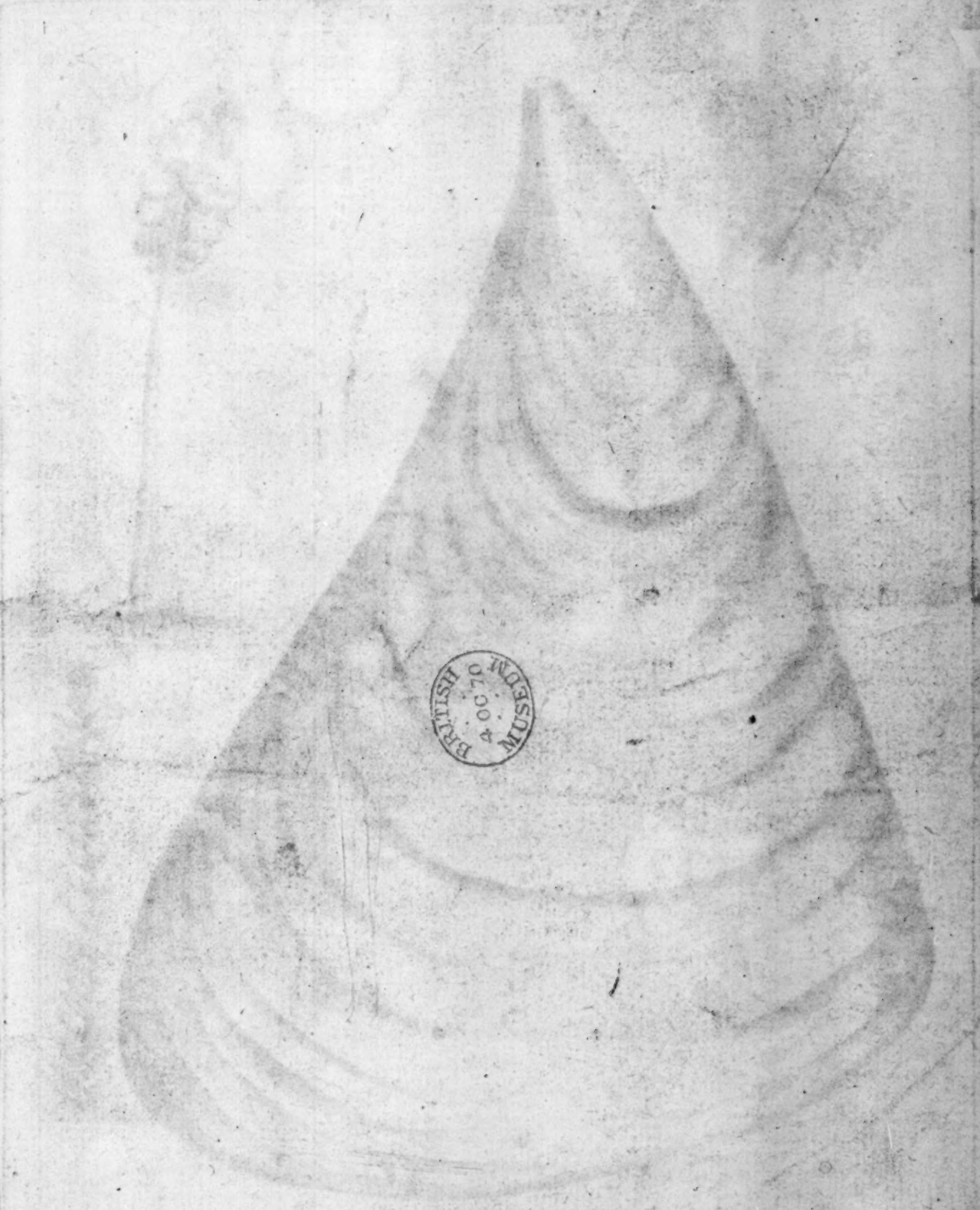

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Table I.

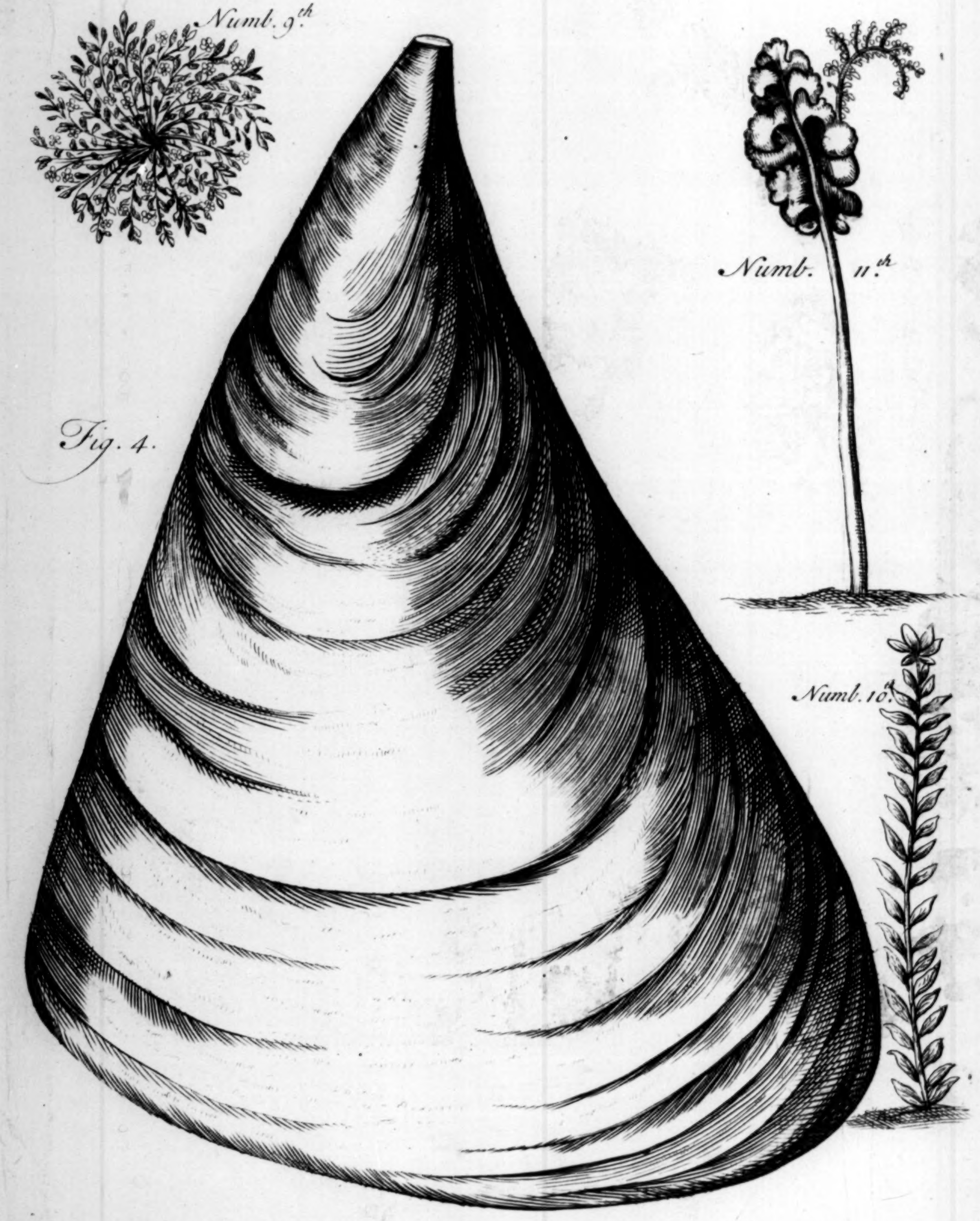

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Fig. 4.

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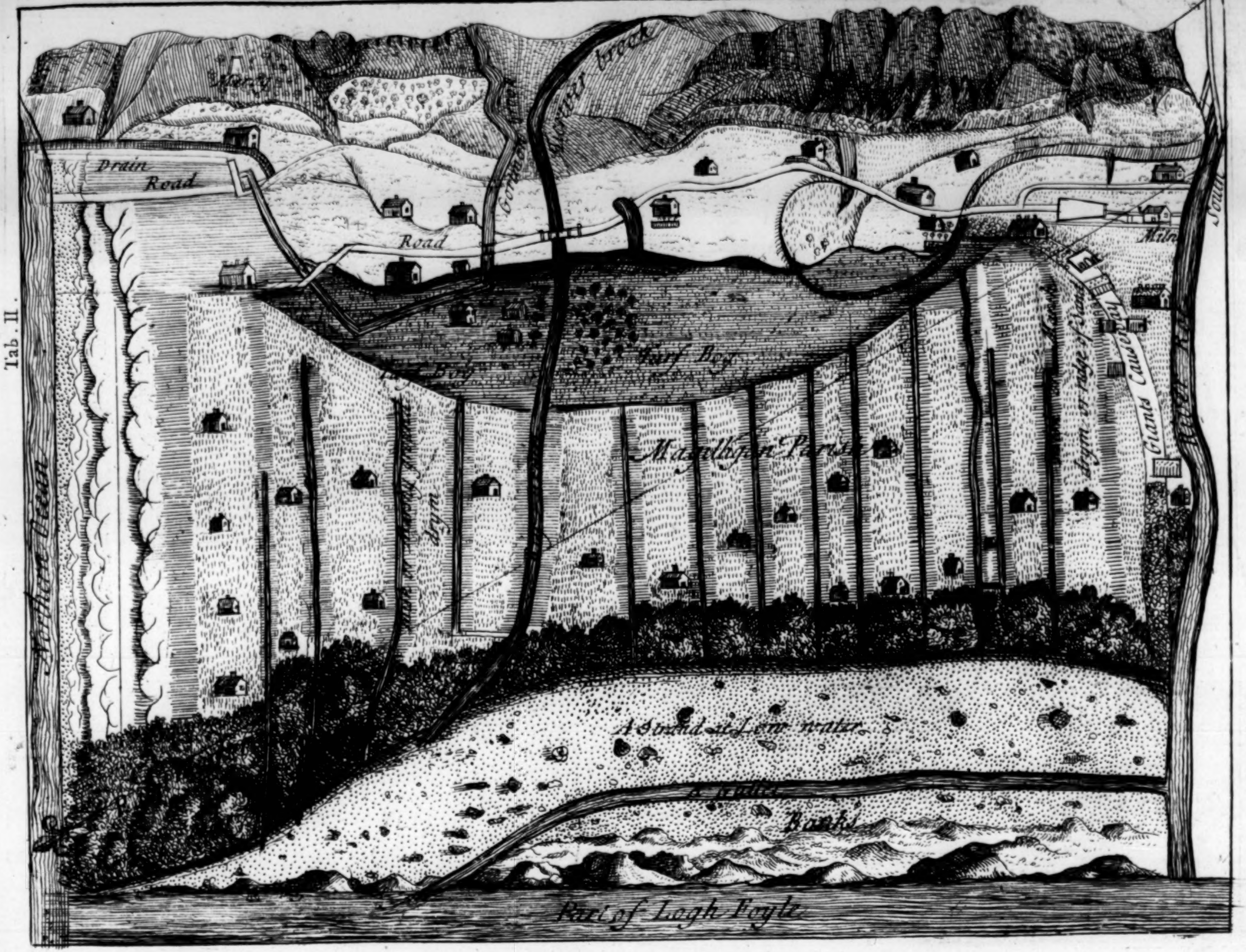
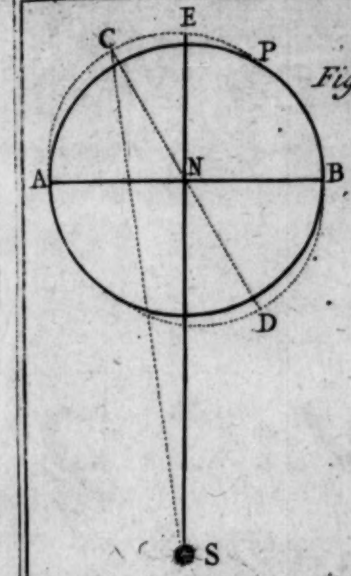

Northern Ocean
Drain
Road
Road
Gorinon brook
brook
Turf Bog
Turf Bog
Marsh or Marshy ground
drym
Magilligan Parish
Marsh
drym or ridge of Sand
Giants Causeway
Miln
River Rol
South
A Strand at Low water
Banks
Part of Logh Foyle

Tab. III.



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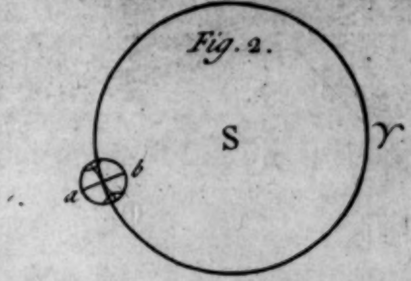

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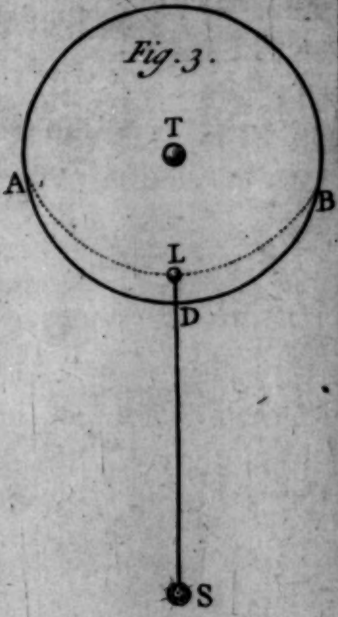

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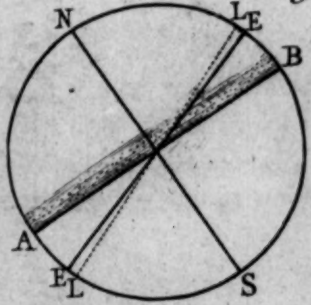

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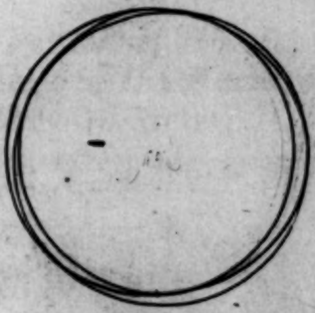

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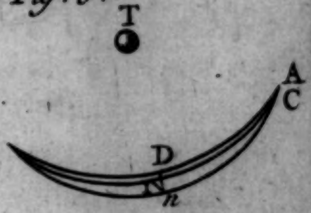

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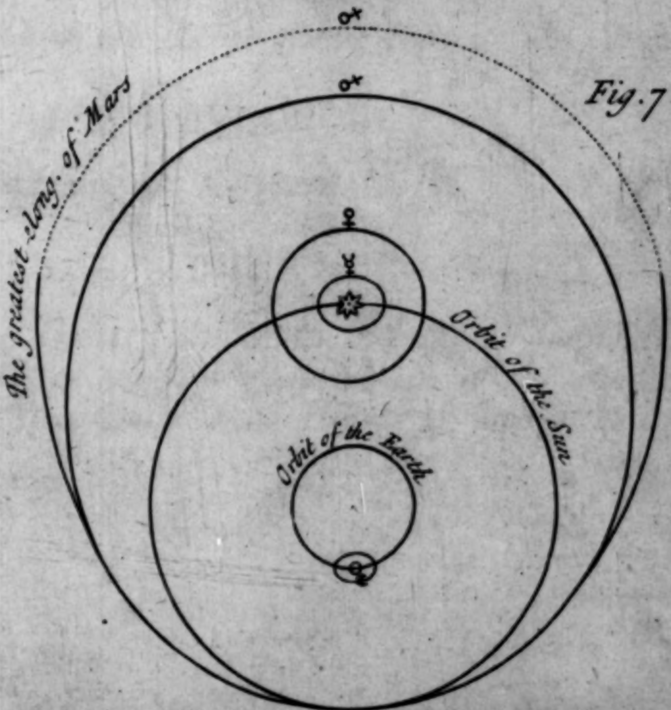

Fig. 7.

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MISCELLANEOUS LETTERS

On Several SUBJECTS in

Philoſophy *and* Aſtronomy.

LETTER I.

An Account of the great Variety of Plants, Shell-Stones, *and many other Curioſities in the Pariſh of* Magilligan *in the County of* Londonderry *in* Ireland; *together with a curious Account of the forming the Land, being formerly under Water.*

My LORD,

IN Obedience to Your LORDSHIP's Command, I have made the beſt Inquiry I could into any thing ſingular hereabouts; did I underſtand Botany, I believe this Pariſh could afford as good a Collection of native Herbs, as any one Place in the Three Kingdoms. We have Wild *Thyme*, Wild *Sage*, *Tongue Graſs*, *Garlick*, Wild *Strawberries*, *Juniper-Berries*, *Maidenhair*, and formerly a ſmall wild *Black-Cherry*, which is now quite deſtroy'd; a very great Variety of *Chick-Peaſe* and *Vetches*, a great Variety of *Trefoyl* and *Crowfoot*, *Plantains*, *Water-Lillies*; two Sorts of *Dwarf-Sallies*, or *creeping-Willows*, and a great variety of other Herbs well known; and a great Number I know neither Names or Uſes for. In a word, it's the *Phyſic-Garden* for the *Iriſh* Doctors both far and near; the Reaſon is the great Variety of Soil.

The *Iriſh* have Herbs for Diet, for Phyſick, for Dying, and almoſt for all Uſes; they uſe a *Pentaphyllum rubrum*, (in Iriſh *Crowlean*) to thicken their Milk ſuddenly, by rubbing their Veſſels with it: and by the way, I cannot think it the ſame with *Parkinſon*'s and *Ray*'s; for this carries no red Flower, nor any Flower, but Purple Hairs on a Stawberry-like Button: But whether I miſtake them, my Lord, I will not be poſitive. The Tops of the yellow Ladies Bedſtraw they uſe for dying Yellow, and the Roots for a Madder Red. *Crotter*, a ſort of Moſs on Stones, dyes a good Gold Colour. *Corkry*, another Scurf on Stones, dyes a Peach Colour. The Roots of the White Water-Lilly, a Black. In a word, we can dye moſt Colours with our native Growth, but Blue, or what depends upon it. The Roots of *Tormentil* (in Iriſh *Namnat*) hath been uſed by the native *Iriſh* to tann Leather. We have alſo a mighty Herb in the *Iriſh* Opinion, uſed in Charms, which grows on our Mountain; it's *Parkinſon*'s *Pes Catti*, or *Gnaphalium Montanum*.

But theſe following Herbs I now and at other times have ſent you, I think deſerve more particular notice: 1. A Yellow *Violet*, which differs from the Yellow *Panſy Violet*; The *Panſys* do not flower with us 'till *June*, whereas this other I have pulled the firſt Week of *April*, and flowers the ſame time with the wild Blue *Violet:* I own it differs nothing from the Yellow *Panſy*, but in the Largeneſs of the Flower and Seaſon. 2. A *Spring Gentian*, that I pulled in *May*; it is much larger than the *Autumnal Gentian*, of which we have plenty: The *Iriſh* Doctors miſtake the Spring *Gentian* for a Blue *Centory*, and uſe it as ſuch, tho' in nothing like *Centory*. 3. A *Ranunculus* that grows on our higheſt Rocks: it flowers in *May*; I take it to be the *Ranunculus Alpinus Betonicis Folijs* of *Parkinſon*; the Leaves are very like thoſe of *Betony*, only very White on the under ſide; it carries a Flower of eight very White ſhining Leaves, yet when the Leaves are fallen, it carries an exceeding beautiful White Down. 4. A *Naſturtium Montanum*, with Leaves almoſt as fine as the Common *Maidenhair*. 5. Two ſorts of ſmall-leaf'd Mountain *Plantin:* that on the Rocks next the Sea, hath ſmoother Leaves, and turns backwards fully round. 6. Two Sorts of Heath, with White Flowers, the one common with both Leaves, the other with an open Flower and Yellow Chives in it. 7. I think is a kind of *St. John's Wort* (in Iriſh *Shammar Marie*): It is not like thoſe deſcribed in *Parkinſon* or *Ray*; I have ſent ſeveral Sorts of *St. John's Wort* and *St. Peter's Wort* to your Lordſhip, that you may compare them: This creepeth on Rocks or very dry Ground, is rounder leaf'd than *St. John's Wort*, but not ſo round as *St. Peter's Wort*; a much finer Herb, and ſhoots one Yellow Flower only from a Joint, not in a Spike at top; it is later in flowering, and much larger leaf'd than *creeping St. John's Wort*, and round ſtalk'd. 8. Beſides the common Sorts of *Serpillum*, or *Mother of Thyme*, I have ſent Your Lordſhip one ſort, that riſeth out of the ground with a Grey ſcaly Head, like *Parkinſon*'s true *Thyme*; the Leaves are lighter than the common ſort, but not ſo light as the White; the Flowers are a pale Purple, and is the lateſt ſort. 9. I ſend Your Lordſhip a beautiful ſort of Herb; it grows on dry Spots in our boggieſt ſort of Ground, the Stalks are as fine and ſhining Hair-colour as the *Maidenhair*, with Leaves like *Serpillum*, yet ſingly at half an Inch diſtance, on one ſide a Dark Green, on the other a Sea Green: the Herb as it lies on the ground ſpreads round, lies cloſe and thick-ſet, and is very pretty; it bears after *Michaelmas* a Red Flower with four Leaves: It is not the *Red Wort*, nor like it, when compared; if it is not to be reduced to a Species of *Adiantum*, I know not what it is. 10. I ſend alſo another Bog-Herb, of four or five Inches high; it bears a Yellow Flower of five Leaves, the Leaves on the Stalk are yellowiſh, ſet thick and cloſe to the Stalk alternatively, ſo that the Stalk cannot be ſeen. 11. I ſend Your Lordſhip a kind of *Ribes Montanus*, the Berry is exactly like a red Currant, but not of ſo quick a Taſte; it hath but one Stone, whereas the *Currant* hath three; the Stalk is woody, like the *Vitis Idea*, the Leaves like the *Currant* ſhoot Strings like the *Strawberry*; the Fruit grows on ſeveral Stalks, like an *Umbell*, on each Stalk is a Knot of ſix Berries about, and a larger in the middle. 12. A beautiful ſort of *Fern*, I cannot find it in the Herbariſts.

We have alſo the *Connough Worm*, Black *Slate*, a White and Grey *Fuller's Earth*, and the Shell of a Fiſh we have no Name for, either in the *Engliſh* or *Iriſh*, ſo thin, that it is difficult to convey one to Your Lordſhip whole: The Fiſh is very ſcarce, and I believe is a Nondeſcript; ſeveral of the Shells are nine Inches long, and ſix Inches at the broad end, and ſcarce half an Inch at the other. *Vid.* Fig. 4. In many of our Stanks in the Low-lands of this Pariſh, tho' Freſh-water, are variety of Shell-Fiſh: I have ſeen *Cockles*, *Wilks*, *Periwinkles*, and many other ſorts, but very ſmall, the flat kinds ſcarce ſe big as a Man's Nail, and the reſt proportionable: and what adds to the ſtrangeneſs, is that in a dry Summer, when the Water is dry'd up, and the Fiſh muſt neceſſarily dye, yet the next Spring we ſhall find them as numerous as ever: I can think of no other Cauſe, but that they ſpawn every Year. I was ſuſpicious that they were not alive, until I found they had freſh Fiſh in them; but how they came there, I cannot anſwer any other way, than by ſuppoſing them to be left there or their Spawn, when the great Change was made of this Place from Sea to Land.

That this Land was formerly Sea, I think there is ſufficient reaſon to believe, for along at the Foot of the Mountain, and all the Coaſt is the old Bank to be ſeen, to which the Sea hath formerly flowed, at the foot of which every where is Sea Sand and Shells to be dug up. And the *Giant's Grave*, another Curioſity in this Place, proves it; it's a Mile and half long, one Limb of him lies at *Balſpoint* at the Mouth of the River *Roe*, paſſeth by Mrs. *Gage*'s Houſe, and under my Houſe, and along the High-way a Quarter of a Mile farther: Its a Ridge of Stones, ſuch as the Sea throws up in Beaches, mixed with Shells and Sand; beſides, near my Houſe, a Mile from the Sea, at the Foot of the Grave, is the quick Sand, raiſed at the ſecond Spade, and at the digging ſeems to be a ſmall Shell, but when ſome days in the Air, turns to Duſt. The other Limb of the Giant, the *Iriſh* Fable makes loſt in a Battle, but of late they have diſcover'd ſome more of him, by a Shell-Bank under *Belly-Caſtle* Orchard, two Miles now from the Sea up the River *Roe*, and another Bank of Shells, more than a Mile farther up at *Shrieve*, near the Road from *Newton* to *Colrain*.

The Low-Land of *Magilligan* is divided into Ridges (or as we call them *Dryms*) of Sand from one hundred to five hundred Yards broad, higheſt in the middle, and ſloping on each ſide, to marſhy Ground (which we call *Misks*) commonly as broad as the Dryms: The Dryms are generally from ſix to twelve Feet higher than the Misks; but on the North ſide next the Ocean, the Dryms and Misks are narrower, and the Dryms ſome of thirty or forty Feet higher than the Misks. Both the Dryms and Misks run parallel almoſt, firſt a Drym, then a Misk, interchangably, the whole length of the Pariſh, for five Miles: The length of the Dryms run from Eaſt to Weſt, from the Mountain to *Logh-foyle*, and is in moſt Places two Miles long, in ſome places leſs, in ſome more; only for half a Mile, next the Mountain, it is all one Bog and Level. The Cauſe of this and of the Lands ſettling in this Bay, cannot otherways be accounted for, but by the General Deluge; for I am fully perſuaded, that the Rivers that fall into *Logh-ſoyl*, could not with all the Sand and Mud that they carried down in Floods form ſo large a piece of a Country, as is this Pariſh and *Meroe*, and the Flats of *Bellikelly*, beſides many other Places. As to *Magilligan*, it is ſo far from adding to it, that it bears no proportion to the Land, and is every Year taking from it on *Logh-foyl* Side: There are Men alive, who know the Land to have loſt above an hundred Yards. And if we can make any thing of *Iriſh* Fables, the Flats of *Logh-foyle*, which extend in ſome places a full League, have been formerly Part of this Land. There is a Rock on the ſide of the Mountain, called the *Poor Woman* (in Iriſh *Calliagh Veerboght*), who tells us, when ſhe was a Maid, the Place where ſhe ſtands was once Corn-ground, and *Logh-foyl* ſo narrow, that a Lamb could skip from *Magilligan* Point to *Green-Caſtle*, which is now two Sea Miles diſtant; and the Fairy that lived on the *Tuns*, Banks that lye at the Mouth of *Logh-foyle*, (moſtly formed I believe by what was worn away of this Shore) having a Carpet ſtole from him by one of this Pariſh, Curſed it, and threaten'd that every Year the Breadth of the Carpet ſhould be ſwept away from the Land, 'till all ſhould be ſwept away. We may at leaſt gather from ſuch as theſe, that in antient times this Place was loſing and not gaining.

The Growth of the Bog in the misky Ground, in ſome Places near the Mountain, to ſix or eight Feet, ſhews there hath been no Alteration for many Ages, it is likely not ſince the Flood; for tho' that ſort of Bog doth grow, as Your Lordſhip may learn from all hands, yet not to ſuch a height in many Ages; another Reaſon, to think that this Land, yet remaining, hath had no conſiderable Alteration, at leaſt theſe thouſand Years, is that the Misks have been all cover'd with large Oaks and Yews which grew to that perfection: Since the forming the Land (for where any of the Dryms are cut through with blowing, there is not the leaſt mark of any Wood or Roots of Trees, whereas the Misks are full of Roots, and ſome Trees found under the Bog, the Oak almoſt all rotten), there were alſo ſeveral large Horns of Deer found in cutting a Drain, ſome of them even decay'd to Rottenneſs: This could not be in a ſhort time, conſidering nothing preſerves from Corruption like our Turf Bogs.

But as Mr. *Rowland* obſerves in his *Mona Antiqua*, the Deluge muſt have born down off the Mountains a great quantity of Earth, Mud and Sand, and this likelieſt to ſettle in the Bays deepeſt within land, and moſt out of the Current, ſuch as this Country ſurely was. And if we compute by the Account we have of the Deluge, we ſhall find the Current of the Waters was very great; for we find in ſixty Days from the time that the Tops of the Mountains began to appear, the Waters ran off the face of the Ground; which by a moderate Allowance, reckoning the Mountains to be a Mile and half high, tho' there are Mountains much higher, comes to decreaſe about forty three Yards a Day; now our Spring Tides here, unleſs in Storms, ſcarce riſe four Yards, which running out in ſix Hours, makes but ſixteen Yards a Day; ſo that the Current of the Waters at the Deluge, when within the Mountains, muſt be near triple as ſwift as our Spring Tides: This aſſiſted by a ſtrong eaſterly Wind, which it is likely then blew, drove the Mud and Earth from the Mountain towards the *Logh*, almoſt to the Quick-Sand, within half a Mile of the Mountain, but proceeding farther, met with a ſtronger Current down *Logh-foyl*; which adding to the Dirt and Glit much more from other Places, this Bay being much out of the way of the Main Stream, our Water not being able to force the Mud, againſt ſo ſtrong a Current, broke its way through the Mud, almoſt at right Angles in ſo many ſeveral Streams as there are Miſks, and ſwept all away to near the Quick-ſand.

The Mud therefore being kept together by a Current on each ſide, and a greater in front, muſt ſettle in ſuch Ridges the heavier Sand neareſt the Mountain; which ſhews the Stream came from thence, which it never did but at the Deluge: and this is now our Arable Land, without any Mixture of Clay or Earth, only the Top of the Ground for eight or ten Inches, grown fertile by Manure, and the Graſs and Roots rotting in it. The lighter Sands were carried farther down the Stream, and heap'd up together at the Edge of the *Logh* and next the Ocean, which by blowing have received many Alterations. It is true the Dryms and Miſks towards the North Part of the Pariſh, the Ends of them bend a little to the Northward, near the *Logh*, becauſe this Part of the Pariſh ſtretching far out into the *Logh*, the greater Stream carried the leſſer ones along with it, as the Streams of all Rivers are that fall into a greater Current.

The Deluge hath left us other Marks of its Fury, for more than half of our Mountain, is one continued Heap of Stones and Rocks tumbled down, and in particular one Rock left ſtanding upon the ſide of the Precipice, the remainder no doubt of a huge quantity of Rocks tumbled down below it: It is about twenty eight Feet in height, about ſix Yards about, with natural Seams in it, not very well cemented; no Art of the *Iriſh* could place it there. The *Iriſh* do attribute every extraordinary thing to Giants or Faries; it is called the *Merog* or *Finger-Stone*. Your Lordſhip's

Lordſhip ſaw *Solomon*'s *Porch*, the Rock is of White Lime-ſtone, as is all the Bottom of the Mountain along that Strand, and is continued along the low part of the Mountain through this Pariſh, and farther up through two or three Pariſhes more; with us 'tis very hard, and makes Lime: farther up, as in the Pariſh of *Drummacoſe* and *Balteagh*, it is ſofter, and is uſed for Marle: With us 'tis very producive of Flint, and many of thoſe Flints very regular; moſt of the regular Flints reſemble Sea-Shells. I have ſeen ſome of theſe Stones that the moſt careful Examiner could perceive no difference, yet ſome of them, the one half would be well formed, the other ſide lumpiſh, which proved them Stones: I try'd them in Spirits of Vitriol and in Vinegar, and fermented as well as Wall-Shells; ſome of them reſemble Shell-Fiſh, that are not known in this Place: Such a one, my Lord, I ſend You, 'tis what in *England* they call the *Miller's Thumb*, a very winding Stone; many ſuch Stones are found on the Surface of the Ground. But near this Place is a ſhelly Rock, wherein are large Stones, with great Variety of ſuch ſort of Shell-Stones in them. But what aſtoniſheth me, is that in ſeveral Turf-Holes, a Mile from the Sea, and the Holes not cut above five or ſix Years ago, I have taken up Periwinkles alive; I ſuſpected at firſt, they might be a kind of Shell-Snail, not knowing how to account for their coming there; but the exact Shell of the Periwinkle, together with their dying when out of the Water, and not crawling on the Land, and the Shell very unfit for that purpoſe, makes me wiſh ſome Perſon would give any tolerable Conjecture for it, without abandoning the Principle of univocal Generation of all Inſects. I thought, perhaps Fowl might have drop'd ſome of them in ſuch Places, but then the numbers of them ſpoil'd that Thought; or is it poſſible they could live and ſpawn under Bog and Sand ſome thouſand Years, for the Holes were cut to the Sand.

I have ſent You another ſort of theſe Stones, they are found at the breaking of Lime-Stone, in the Heart of ſeveral Stones: The *Iriſh* call them the *Fairy Bullets*; the finer the Lime-Stone, the more regular the Bullet I ſpeak of: It reſembles the Shell of the Sea Urchin, but longer in proportion, and not ſo flat at top, the Baſe divided by five double ſmall Ridges dented, meeting exactly in the Center, where it looks as if it were broke off a Stalk; theſe Ridges are continued to the Top of the Stone, where they meet, ſome in a little Knob or ſmall Hole. I confeſs I cannot conjecture from whence ſo great Regularity ſhould proceed, and ſo exact a Likeneſs in multitudes of ſuch Stones: I am inclined to believe an uniform Production and Growth of Stones as well as Metals, for from whence ſhould proceed this plaſtic Power in White Lime-Stone and Chalk to produce Flint, for the Stones I am ſpeaking of are Flint: I have ſeen ſeveral of them broken, ſo that Flint ſeems to have had its time in Fining and Growth; what confirms me more in this, is that half an Inch of the Outſide is like the Lime-Stone, as if that Part were not as yet well digeſted. That there is a *Succus Nutritius* convey'd to theſe Stones, and proper Paſſages in them, the ſingular Regularity of them perſuades me.

There is a curious Stone with a Gentlewoman of this Pariſh, found in the Neighbourhood, a White tranſparent Stone, coarſer much than a Cryſtal, an Inch and half long, near an Inch broad, and three quarters of an Inch thick, of a very irregular Shape and uneven Surface, one Corner of it inclines a little, and that Corner is concave in part and rugged in the other, without any Crack or Bubble within; on the Corner appears all the Colours of a Rainbow, in a beautiful Section of a Cone, with the Convex ſide towards us; the Summit of the Axis ſeems to have been in the Angle, but a Bit is broken off, we can only gueſs the Axis to be half an Inch: it is divided into ſix parallel Zones, near half the Cone appears, each Zone near $\frac{1}{12}$ of an Inch: The Colours are at the Baſe, firſt a ſmall Edge of Orange, next Green, then a beautiful Roſe Red, and ſo interchangably Green and Red to the top, without any Interſpaces, only as the Shape of the Cone requires, the farther up the leſs. The Colours appear in any Poſition of the Stone, whether the Baſe be next us, or the Side, or Top of the Cone, within the Angles of Reflection, from 42 to near 50°; the Colours appear brighteſt about 46°, and as the degrees are varied, ſo do the Brightneſs of the Colours vary, and when fainter, the Red inclines to Purple, and the top of the Green to Yellow, and the lower part of the Red to Orange; but the Stone is every where ſo irregular, that I could not ſo exactly apply any Inſtrument to it.

I cannot conceive the Geometrical Figure of Salts, or the Germination of them, can produce the odd Variety and Ornaments of Shell-Stones. I ſaw one not unlike a Red Berry: The Stones do not crackle in the Fire; it is moſt likely they are form'd as Shells by a *Succus Nutritius*, for the one is as unaccountable as the other.

I am, My LORD, with all due Reſpect,

Your moſt Obedient and Humble Servant,

MAGILLIGAN,
June 2. 1725.

ROBERT INNES.

LETTER II.

On the Declination of the Sea.

My LORD,

IN Purſuit of thoſe Enquiries which I have made relating to the Declination of the Sea, the following Obſervations have occurred along the ſeveral Shoars where I have travelled. I took notice that there are Marks of the Sea flowing to a much greater Height, and in ſome Places farther off than the preſent High-water Mark. On this Remark I began to conſider whether the Waters of the Sea might not be diminiſhed, and the Level of the Surface lower than it was in former Ages; and upon Tryal I found *Magilligan* the fitteſt Place I have ſeen for proving this Matter; all the Low and Marſhy Ground having Drains without any thing to obſtruct the Flowing of the Sea into them: but perceiving that the Flux of the Sea had reached but a little way up, I concluded that all the Flat Ground had formerly been covered by the Sea, becauſe of the Sea Sands, Shells, and Quick-Sands that every where abound among thoſe Drains which reach even to the Foot of the Mountain. The People have no Wells but where they dig to the running Sands, but find the Water of thoſe Springs none of the pleaſanteſt.

But what confirmed me in my Opinion, was my obſerving that the Bank of Sea-Stones (called the *Giant's Grave*) which in a curve Line encompaſſed this antique Bay near a Mile and half in length, beginning from a Point of the Mountain that juts a little out, to the Mouth of the River *Roe*, up as far as *Lough-foyl*, a remarkable Ridge of it runs five hundred Yards in Length near the *Lough* or Arm of the Sea. From this Ridge the Wind having blown away the light Sand, leaves the *Grave* not unlike the Roads in *Holland* with a little ſhort Graſs on it. Having meaſured it, I found its perpendicular Height above the higheſt Sea-Mark to be eight Feet and an half.

But obſerving that the Top of it has been work'd away in former Ages by the Sea and the River, I examined the upper part of the Grave next the Mountain, and by the Help of a Water-courſe and two Sluices, I levelled the Water with the Top of the Grave, and found it to be eleven Feet higher than the higheſt Tide; from whence I drew this Concluſion, that the Level of the Sea is lower ſo many Feet than it was at the time when it flowed to the Top of this Grave. As to the time when this might probably happen, I ſhall offer my Reaſons why I believe it was at the Deluge; becauſe the Regularity of our Dryms or Ridges of Sand, and of our Misks or Mariſhes, prove our Land was formed at once, and the Dryms being generally much higher than the Grave, could never be thrown into that Form by the Sea, but more probably at the General Flood; and farther, within the Compaſs of the Grave, no Stones appear, but on the Outſide of it near the River are Degrees of ſuch Banks of Stones and Shells down to the preſent Level of the Water, which ſhews that the Sea has inſenſibly declined. The Reaſons why I date this Account no higher, are, that the Space between one part of the Grave and the Mountain, of the Length of about a Quarter of a Mile, contains the like Sea-Stones and Sand before-mentioned, but within the Grave are none; which ſhews that the Tide flowed not there ſince the Formation of the Land. Another Reaſon is, that a longer Time cannot be allowed, becauſe, a leſs Decreaſe of the Waters will not anſwer for the ſpoiling, in the ſpace of two thouſand Years and under, all the antient Harbours, whoſe Channels lay not very deep; which is better accounted for this way, than by telling us that the Sea advances in ſome places and falls off in others, a Notion ſo contrary to the Rules and Laws of Hydroſtaticks. This likewiſe affords a more rational Argument than others have given for the conſtant Influx of the Sea at *Gibraltar:* for more Vapours being exhaled by the Sun in that hot Climate than there is Water returned by the Rivers, the Sea muſt neceſſarily flow in to afford a ſufficient Supply for the *Mediterranean.* And laſtly, the Stones, of which the Grave is formed, muſt have been ſome Ages in working to that Smoothneſs and Roundneſs in which they now appear.

But that I may avoid any erroneous Raſhneſs, and aſſert nothing but what I have ſome Reaſon to ſupport, I have examined what our Geographers and ſeveral Travellers have ſaid of our antient Harbours, and I find that the Sea is fallen away from *Cheſter* to that degree, that the Harbour is ſpoil'd: The *Cinque Ports* likewiſe, ſo famous in the *Conqueror*'s Time, that they were thought the Keys of the Kingdom, and furniſhed our King with many Ships of War, are now fit for little elſe than the harbouring of Fiſh-Boats. The Sea has likewiſe declined from *Ipſwich*, *Winchelſea*, the *Fens* of *Ely*, and no doubt from other Places alſo, not remarked by Travellers. As to *Holland* and the *Netherlands* in *Cæſar*'s Time, by the Account he gives of it, the *Sea* ſeemed to be then juſt leaving it; for he repreſents what is below *Tournay* and *Lovain* as full of Lakes, Marſhes, and Half-Iſlands, made by the Tides, that the Inhabitants had no Towns, and were rude and barbarous; *Cæſar's Comment. L.* 6. The *Rhine* is alſo deſcribed as entring the Sea by many Mouths, and makes numerous and great Iſlands, which before *Druſus's* Canal was made, and the *Bailiwick* of *Dort*, cut off by the Sea, about three hundred Years ago, it neither according to the preſent Face of the Shore had many Mouths, nor makes ſuch Iſlands; for the Iſles of *Zealand* are formed by the *Scheld.*

Farther, *Cæſar* ſhip'd off his Forces for *Britain* from *Portus Ictius*, which by the Diſtance, the antient Name, the Country of the *Morini*, and its Situation, was certainly St. *Omer's*, where appear the Marks of a capacious Bay: And in all likelihood *Calais* and the *Pais recuperais* were then under Water; otherwiſe *Cæſar* would never have called any Part of the *Morini* the neareſt Paſſage to *Britain.* Neither would ſo fine a Land as is in *Low Flanders* and *Holland* have lain uncultivated to that time. Other Parts, as *Caen*, *Harfleur* and *Bullogn*, are Inſtances of what I ſay. As to the reſt of this Coaſt, it conſiſts of large Eſtuaries and deep Water; and the Tides flow on it to ſuch a Height that ſmall Alterations are not ſo much to be notic'd; yet the antient Harbour of *Vannes* is not in near the requeſt it was in *Cæſar's* Time, and is alter'd from the Deſcription he gives of it.

But the *Mediterranean* affords us the beſt Account of antient Harbours. *Carthagena* in *Spain* was once reckon'd the beſt Part in that Sea, but now not near ſo good as it was, and *Ravenna*, the moſt commodious Receptacle for Shipping in the *Adriatic*, is entirely loſt, the Sea having left it four Miles. *Rimini* is in like manner forſaken by the Sea; and whatever *Coronelli* might tell Mr. *Addiſon*, yet the Sea muſt decline at *Venice.* It is true their Care in ſcouring their Channels may keep them ſtill deep, and the Decreaſe of three or four Inches in a Century not be regarded, which in two thouſand Years amounts to a great deal. *Nero's* famous Part of *Antium* is now uſeleſs. So *Oſtia*, the *Roman* Port in *Iſchia*; ſo *Ænetria*, an Iſland in *Virgil's* Time, is now joined to the main Land; *Trani*, *Tarentium*, and *Brunduſium* are like Inſtances. On the Coaſts of *Greece*, *Athens*, the two Ports of *Corinth*: In *Aſia*, *Tenedos* where the *Grecian* Fleet harboured, is now nothing; *Epheſus*, *Chios*, *Sidon*, *Joppa*, *Alexandria*, and many more. And that this is general,

Cambaya

Cambaya in *India*, and *Jucatam* in the Bay of *Mexico*, a Peninſula made up of Shells and Sand, are eminent Examples.

The Cauſes which may be aſſigned for the Declination or Decreaſe of the Sea are various, *viz.* the Vapours that are raiſed from the Surface of the Waters; many of which never return by Rivers, but are conſumed on the Growth of Animals, ſome on Foſſils, Minerals and Stones, others on Herbs and Plants, ſome on the Growth of Bogs and Marſhy Ground, which in Cold and Wet Countries is very conſiderable; even Stones perpendicularly ſet, gather a Scurf, as doth untill'd Ground Fog, Moſs and Heath, and the moſt barren Part of it to a conſiderable Thickneſs. The high Mountains and Lands near the Poles retain the Snows; the Streights of *Gibraltar* muſt leſſen the Ocean.

As to that Objection, that the Sea has encroached on ſome Places, as it has done near *Dort*, the *Goodwin-Sands*, and even on theſe Coaſts, may be eaſily conceived without raiſing the Sea in its Level; for ſuch Lands lye low, are ſandy or ouzy Grounds, and are waſhed away by the Sea in Tempeſts. It is very true, that when the Sea grows ſhallow, it hath the greater Influence on the bottom, and throws up a good deal of Sand; but this is chiefly occaſion'd by the Shallows of the Water; for there were Tempeſts in former Ages as well as now, and yet ſuch Towns as can ſcarce keep their Harbours from being quite choaked up, had no ſuch Difficulties in antient Times.

I am, My LORD,

Your moſt Obedient and Humble Servant,

MAGILLIGAN,
Aug. 3. 1725.

ROBERT INNES.

LETTER III.

Of the Northern Streamers.

My LORD,

I Could wiſh the Gentleman that wrote ſo exactly of his *Aurora Borealis*, had given us his Conjectures of the Cauſes of it, it would have been more ſatisfactory than any thing I can offer on that Subject.

This Meteor has, for about twelve or fourteen Days paſt, much more frequently appeared to us in this Northern Coaſt than formerly; ſcarce a calm Night in Winter paſſeth without ſome of them. Out of many I have choſen that which was ſeen the 27th of *April*, 1726. about ten o' Clock at Night, which was preceded by one the foregoing Night; not that it was more ſurprizing, or near ſo viſible as the *Aurora Borealis*, or as many others we ſee, but for ſome particular Circumſtance, which may render what I have to ſay on this Subject plainer and more intelligible. The 27th was a warm and fair Day, what Breeze there was blew S. E. with us, but the Afternoon was calm, except about an Hour in the Evening that we had a ſmall Breeze from the North. About Sun-ſet the Dew fell plentifully, and as ſoon as the Day was cloſed, the Streamers began to appear very thin and diſperſed, the Horizon clear and free of them, but on the reſt of the Sky from N. E. to S.W. on the Weſterly Side of the Hemiſphere, were many faint and ſcatter'd Pieces of this Vapour, ſo tenuous and ſubtle that the Stars appeared through them; their Baſes towards the Horizon were broader than towards the Tops, where they ended in Points; all the Flaſhings and Vibrations begun at the Baſes were brisker and brighter than as they aſcended: Such as appeared flaſhing near the Moon ſhewed the Red and Green of the Rainbow, but ſo ſwiftly changed from one Colour to the other, to and fro, that I could not diſtinguiſh the intermediate Colours. Theſe Colours were viſible no where but in the Place of the greater *Corona luneris*, about 23° from the Moon. This Meteor never darts ſo nimbly, but our Eye can follow, nor is comparable to Lightning for Swiftneſs. I would farther obſerve, that the N. N. W. is the Seat of this Meteor, and of our Winter Thunder; for a N. W. Storm in Winter is generally accompanied with Thunder.

I look upon the Earth and its Atmoſphere as a great Laboratory, whereof I take the Sun to be the Fire, and the ſeveral Regions of the Air as ſo many Receivers, one above the other; to Earth ſubſide the *Caput mortuum*, all terrene, ſaline, and groſſer Parts; the Sun exhales all manner of Vapours, Volatile Salts, Sulphurs and Oyls, and many more than yet are known; their Figure, Gravity, but eſpecially the Winds, are the Cauſes of various Compoſitions and Meteors.

But to come cloſer to my Deſign: It is not properly a Flame of Fire, as is evident from the Colours made by the refracted Light of the Moon; for never was Light ſo refracted through a Flame of

Fire, but loſt in it: Neither is it compoſed with the ſame Exhalations with Thunder and Lightning, becauſe it wants thoſe nitrous Particles that give Force and Noiſe to Thunder. Nor laſtly does it appear to have any Sulphur in its Compoſition, for the Light in ſo thin a Vapour would be tinged with Blue, and would ſmell offenſively. The Colour of Falling Stars betrays the Sulphur in them: The Flame of diſtilled Spirits are likewiſe coloured Blue.

What remains therefore known to us in the Chymical Solution of Vegetables or Animals into Volatile Parts that are inflamable, are the Oily Particles; and of theſe the pureſt and moſt ſuſceptible of Flame and Light is the *Phoſphorus*, or the Chymical Oyl of Urine, than which nothing is ſooner ſet into a Blaze: The Qualities of this Preparation anſwer all the Phænomena of this Meteor. It requires a calm Night for the ſeveral Exhalations to aſſimilate and take their proper Places, as their Gravity or other Qualities may direct; and Eaſterly Winds may poſſibly blow them from the Continent, and when ſtopped by the copious watry Vapours from the Weſtern Ocean, not being able to mix with them, get together, and when in a thin Body, are not ſufficient to raiſe a Fire, but emit a kind of faint Flame that neither heats nor burns; like the dry Phoſphorus when rubbed on Cloaths, ſlightly throws out ſuch a pale, harmleſs, undulating Light, but if expoſed a little longer to the Air, it ſoon paſſeth into Flame and Fire. So the greater and more compleat the Baſis or Cloud of our Meteor is, the larger and ſwifter are the Coruſcations and brighter the Light; and if as yet they become denſer and more compact, it is converted into Lightning and Fire without Noiſe or Thunder: ſuch are often ſeen for almoſt whole Nights together near the Horizon, and are miſtaken for Thunder at a great diſtance.

Of the ſame Nature are Chaſms: That which ſome Years ago I ſaw was very aſtoniſhing and frightful. A great Part of the Sky betwixt N. and N. W. ſeemed to open and repreſent a vaſt Flame of a Blood-red Colour: It laſted ſome Minutes, and dying away, appeared like a burning Mountain in the Sea. I perceived no Heat nor ſulphureous Smell, tho' it reached forty or fifty Degrees in Height, and extended along the Horizon from N. to N. W. That it was compoſed of ſuch oily Exhalations, the Colour inclines me to believe, for moſt Chymical Oils are Red, and that ſuch Oils are eaſily inflamed by the Air, is evident from the *Phoſphorus*.

We may in this Meteor ſee the Nature of that Motion that creates Light and Fire, which is plainly Vibration: for as the Velocity in-

increaſeth, the Meteor inclines more to a Flame-Colour, 'till at laſt, as in the *Phoſphorus*, it is changed into real Flame and Fire. I obſerved farther, that a conſiderable Velocity and Heightening of the Colours did not ſo attenuate the Particles of it, but that it could refract coloured Rays: As alſo that the Air is neceſſary (and perhaps the Northern Air, as being moſt free of Vapours) to put this Exhalation in Motion.

There are many other Things that ſhine in the dark, when the unctuous Particles of them are ſet into a vibrating Motion: But nothing of this kind caſts near ſo great a Light as the Bogs in *Ireland*, which a Horſe travelling over in a dark and calm Night kicks up the Turfs, which ſhine at a good diſtance, and his Feet and Footſteps ſeem all on Fire, and continue ſo for ſome Minutes. The Inflammability of the Turf proves that it abounds with an oily Subſtance.

However, the Difference betwixt ſuch faint Light and real Flame and Fire, ſeems to conſiſt in the Groſſneſs of its Subject Matter, together with the different Degrees of Velocity of Vibration. I have taken notice, that if the Streamers are violently and ſwiftly darted, and in great Numbers, with a dark Cloud for Baſis, that Storms follow.

If theſe Conjectures ſeem probable, our Northern Streamers may properly be called *Phoſphorus Aereus*. It is obſervable, that this Meteor aſcends from the Horizon upwards at Right Angles, whereas other Meteors dart downwards, as obliquely through the Air.

I am, My LORD,

Your moſt Obedient and Humble Servant,

MAGILLIGAN,
April 30. 1726.

ROBERT INNES.

LETTER IV.

Of Bog-Fir, *and the firſt Planting of* IRELAND.

My LORD,

HIS Grace the Archbiſhop of *Dublin* hath written ſo accurately, ſo judiciouſly, and hath given ſo juſt and true an Account of the Origin and Growth of Bogs, that little more than ſome Gleanings can be expected after him.

Beſides the Cauſes aſſigned by His Grace for the Growth of the Red and Green Bog, there are yet many Parts of the *Iriſh* Mountains covered with Turf about two Feet deep, occaſioned by the following Cauſes; *viz.* The Soil at bottom is a hard, impenetrable Mixture of a whitiſh Clay and Gravel, ſcarcely penetrable by the Pick-ax, and impervious to Water. This Soil throws out a coarſe and ſour Graſs, which being neglected by Cattle, rots, and in proceſs of time turns to Turf. This ſort is the beſt for Firing, yields but few and white Aſhes, gives a clear Light, and is durable enough. This Turf ſhrinks exceedingly in the Drying of it, and is ſo impaſſable to Water, that I have known it lye in a Pond above a Year without being ſoak'd or ſoften'd. In *Magilligan*, there are ſome ſandy Grounds ſo impregnated with a red Sediment like Ocre or Iron, that in the dry Summer 1723, the Blades of Oats that grew on it were of a Copper Hue, yet prov'd pretty good. It is ſo hard, that the Water cannot enter it, and the crabbed Graſs, with which it is cover'd, turns to a Turf four or five Inches high, with a ſhort Heath about three Inches high on the Top. Some Bits of this Sand are ſo cloſely temper'd, that they reſemble crumbling, gritty Stones.

The Green Bog affords a hard and heavy Turf, which, when burnt, leaves a great quantity of foul, yellowiſh Aſhes, and by the Offenſiveneſs of its Smell and Blue Flame, which appear when ſtirred in the dark, ſhould ſeem not to want Sulphur. The Smoak of it colours Linnen and People's Skins; however, when drained, is the moſt fertile ſort of Bogs. The Red Bog, when dry, is too light and looſe for Grain, and becomes what the Vulgar call a *Deaf Ground*; but if wet, it ſtarves the Seed: and yet by ſanding, ſhelling, dunging, or ſowing the Sweepings of the Hay-loſt upon it, may be brought to bear Clover, Daiſy, and good Graſs. Trees thrive well in it, when the Ground is trenched and is clear without Moſs or Canker. Heath thrives mightily on the Red Bog, but is eaſily deſtroy'd by ſprinkling Shells or Sand over it, or a frequent Trampling of Men or Cattle upon it kills it. Sand operates very much on ſuch kind of Bogs, for I have known it in two Years time penetrate four Inches deep into the Swarth, and the Mould above the Sand as looſe as that of a Garden: However, the Green Bog is by much the fertileſt. I am inform'd, it bears Rape-Seed well, which being ſown in Summer, is the fitteſt Uſe the Red Bog can be put to, becauſe in the Spring it is ſo ſoft, as makes it difficult for Cattle to labour it.

But the great Treaſure in theſe Bogs is the Wood found under them. When his Grace the Archbiſhop was in theſe Parts, the digging for this Timber was not much practiſed, but now, upon failure of the Oak Woods, the Country is under a Neceſſity to look for it. The Proprietors of it take abundance of Care of this their ſubterraneous Foreſt. The Bog-Fir is found to excell the beſt Oak in theſe Particulars; *viz.* It is ſtiffer, and not ſo ſubject to bend and warp as the Oak is; nor is the Worm known to pierce or eat into it; and laſtly, it is lighter for a Roof. But on the other Hand, it is not ſo fit for Joiners or ſmooth Work, nor ſo proper for Window or Door-Caſes. If it breaks it is without Bending, and the Damage is ſo ſudden, that we have no Notice of it. In ſmall Work it is liable to ſplit in the boring and working it: I have ſeen Planks and Boards made of it, but generally ſhagged, and being Red, is not fit for Flooring.

It is incredible what vaſt Quantities of this Timber are every Year dug out of the Bogs. All of it plainly appears to be burnt down, except a few Trees that ſeem to have been blown up by the Roots: Even Roots that have no Trunks near them have the Marks of Fire upon them; but no Trace of a Hatchet or other Inſtrument can be diſcover'd, except on ſome Hedge Stakes which I have ſeen lying deep in the Bog cut with ſome Tool. The Roots are all in the fertile Soil and their Trunks cloſe by 'em under the deepeſt Bogs. Some that have been blown down lye higher towards the Surface: I have ſeen many of theſe large Firs dug up, but none of them but what had other Fir Roots ſprouting out on the Tops of the Trunks. Theſe ſmall Roots the *Iriſh* call *Graigs*, about five or ſix Inches Diameter, and very much interrupt the Workmen in ſearching after and digging for the Timber. Some Oak is likewiſe found burnt in like manner, but generally rotten and always lying on the Out-Skirts of the Fir-Wood. Some of theſe Oaks lye ſo ſhallow, that they are ſcarcely cover'd; but theſe are found in the neweſt and lateſt Bogs.

The Time when theſe vaſt Foreſts of Fir were burnt, is the Difficulty we have to account for, and which is ſo remote, that it is not ſo much as mentioned in the Fables of the *Iriſh*: for altho' they call it the *Woody Iſland*, yet no notice is taken of theſe Foreſts that ſeem to have been ſpread over a good part of this Iſle. But Oak, Aſh, Alder, and ſuch like, ſeem to be the Woods they knew or had heard of, no Tradition gives any Hint of the burning them, and therefore they ridiculouſly attribute the Leaving this Timber in the Bogs to the Deluge. The Fir-Tree is forgot to be named as one of their Letters of the Alphabet, altho' it deſerved a Name there better than many others that have a Place in it: Of this I have been informed by thoſe that underſtand the *Iriſh* Language; and we may venture to aſſert, that this Burning is elder than the Bogs themſelves. So that our Conjectures muſt take place as far back as the firſt Planting the Iſland after the Flood; and my Reaſons are theſe:

1. The firſt ſpreading of the Bog muſt be ſuppoſed to begin very early, while the Ground was uncultivated, and in a Country where ſo much Rain falls; and to imagine that the Trunks of theſe Trees could have ſunk through the Bog to the Bottom, may be feaſible to thoſe that have not ſeen 'em dug out. But to ſuch as have been Eye-Witneſſes of the Fact, 'tis wholly inconceivable, becauſe the Roots are burnt cloſe to the fertile Earth, the ſmall Twigs that were broken off the Tops are as low as the Trunks, and the little Roots or Graigs before-mentioned, prove they were never higher ſince they fell.

2. The Devaſtation that has happened to this kind of Tree is ſo entirely compleat throughout the whole Kingdom, eſpecially in the Northern Parts, that there remained not one Wood, nor, as I can learn, one Tree, except what has been planted by the *Britiſh* within theſe hundred Years: This, with their being wholly forgot, confirms my Opinion that the Time is very antient.

3. Another Argument to prove our Aſſertion, is, That Fir-Trees are not naturally produced by the Soil, therefore theſe Foreſts were the Effects of God's firſt Bleſſing upon the Earth after the Flood; which is eaſily conceivable, by examining the burnt Roots or Trunks, the largeſt of which one would not judge to be an hundred and ſixty Years old. This I am apt to believe, the rather, becauſe this Sort of Fir vegetates no way but by the Seed; not by Shoots or Layers, nor by planting Twigs in the Ground, as Spruce, Fir, and Yew are produced: So in theſe Places muſt have been the firſt Growth of thoſe Woods; for if any Trees had been there before, ſome Remains of them would have appeared: for every ſmall String of the Roots, every Twig of an Inch Diameter, is ſtill ſound and freſh, without the leaſt Tendency to Rottenneſs; whereas Oaks of three Feet in Diameter are entirely corrupted and in a manner periſhed. So that I make no doubt but ſuch Trees and Roots might endure many thouſand Years.

4. We may reaſonably ſuppoſe that the firſt Planters would begin with theſe Woods, becauſe they grew on the beſt Soils, were the moſt eaſily ſet on fire, and fitteſt for Fewel. One Man was able to burn down more Wood than one hundred could fell. The Fir-Wood is more readily cleſt by People who can hardly be imagined to underſtand the Uſe of the Hatchet: And we find, that but few Perſons were employed in burning them; for they ſtood ſo weaken'd by Fire, 'till the Wind and Storms blew them down, as may be judged by their lying all on the burnt Side, with the ſoundeſt Part uppermoſt. This Poſition of the Tree often deceives the Diggers, who are never ſure of a good one 'till they have him above ground. The Fires were all ſet to the Bottom of the Trees, ſome are burnt ten Feet up the Sides, ſome twenty, and in others the Fire has got to the Heart of them, and reached near to the Top.

5. Had the Soil, where theſe Woods flouriſhed, been ever cleared, the Inhabitants would never have ſuffered the beſt of their Grounds to run into unprofitable Foreſts; and having burnt down more Wood than they could carry away, the Remainder, together with their Trunks and Roots lying in Heaps, ſtop'd the Courſe of Water, which in time increaſed to a Bog. Yet I ſuppoſe ſome of them might eſcape the Fire, as there are found ſeveral ſuch, which, by ſhedding their Seed, occaſioned that ſmall Growth of Wood, the Roots of which bud out of the Tops of the firſt Trunks: And as the Iſle grew more populous, they ſoon cut down this young Growth, as being more uſeful for their Cottages than the large Oaks, which they could not well manage.

From the whole it ſeems highly probable, that the firſt Work theſe Planters ſet about was Burning this ſort of Wood. What might preſerve the Oak, was the Difficulty in working the ſtony and ſhallow Grounds it generally grew on, its ſprouting again after cut from the Roots; or perhaps the *Druids*, with whom this Tree was ever ſince ſacred, might contribute to its Preſervation. Be that as it will, it was certainly the general Uſe of Fir that was the Cauſe of its Deſtruction.

One Fir-Tree in particular, raiſed by my Direction, and the largeſt I had ever ſeen or heard of, except ſuch as were blown up by the Roots, and lye higher and ſloping in the Bogs, was ninety Feet long, two Feet Diameter at the Butt, and about five or ſix Inches at the Top. I endeavoured by the Rows of Knots on the Outſide, and when cut by the Grain of the Wood, to diſtinguiſh every Year's Growth, and by the Calculation I made, (I am pretty poſitive I am not much miſtaken), could not gueſs the Age of it to be more than a hundred and ſixty Years.

Theſe Reaſons induce me to conjecture that the firſt Planting of *Ireland* was much earlier than is generally believed: For if theſe Trees were the firſt Growth after the Flood, which is very probable, I cannot place this Burning later than an hundred and ſixty Years after the Deluge, or thirty Years after the Diſperſion of *Babel*; which they that place it at *Peleg*'s Birth, do not conſider, that *Heber* at thirty four Years could not have Grand-Children to be Leaders in this Diſunion at *Babel*, as *Jocktan*'s Children were, but at ſixty four he might, which is juſt an hundred and thirty Years after the Flood.

This early Planting of *Ireland* may ſeem improbable to thoſe who ſuppoſe *Noah*'s Poſterity ſpread no faſter than they ſtocked the Countries they paſſed through; but by *Moſes*'s Account we find that God altered this Method; that at *Babel* he confounded their Languages, and divided the Earth to them; that he ſcattered them over the Face of the whole Earth, and that every Tribe and Language went directly to their Portion allotted them, without being ſuffered to ſtop or ſettle by the way. For if Mankind, by God's Bleſſing, was ſo multiplied, that from Eight Perſons they became ſo numerous in an hundred and thirty Years, as to be obliged for want of Room to remove Weſtward to *Babel* in ſo great a Body; no doubt but by the ſame divine Direction and Command, they were much more ſpeedy in peopling the other Parts of the World. This Haſte was very neceſſary, to prevent the Woods from incumbering the Land too much, and the Wild Beaſts to multiply ſo as to need a *Nimrod* to deſtroy them, or what would be more inſuperable, the Bogs.

I know the great Objection to all this, is, that it cannot be ſuppoſed, that in thirty Years after the Diſperſion, the Inhabitants of this Iſland ſhould be ſo numerouſly increaſed, as to be able to burn ſo vaſt a Quantity of Wood as apparently has covered a conſiderable Part of its Mountains as well as Valleys, eſpecially Northward. But we find that all the antient Traditions and firſt Writers of Antiquity, and all the Nations in *Europe*, agree in the ſame Account of the firſt peopling of their reſpective Countries. The *Spaniards* have ſettled *Tubal* in *Cantabria* within ten Years after the Flood, *Tuiſco* near as ſoon in *Germany*; the *Swedes* and *Goths* claim the earlieſt Planting in their Country; *Dodanim* was really in *Epirus*, as the Grove and Temple of *Dodona* ſufficiently manifeſt; *Chittim* ſtocked *Macedon*,

Macedon, as *Iſaiah*, Chap. 23. calls the Deſtroyers of *Tyre* under *Alexander*, and it is likely planted *Italy* too, for *Daniel*, Chap. 2. calls the *Romans* the Ships of *Chittim:* However, *Dodanim* and *Chittim* did not ſtop to plant the fruitful Countries of *Aſia*, but paſſed over into *Europe* to poſſeſs their Inheritance. The *Iriſh* Tradition is, that *Partholanus* with his Colony came here three hundred Years after the Flood, and found Inhabitants on the Iſland (the Gyants *Tomar*), as all *Europe* have the like Stories of their *Indigenes* being Giants; and as the *Greeks* mention their *Titans* as Occupiers of the Country before *Jupiter* and the reſt of their Gods were born. All this could not proceed from ſo many different Nations and Languages without ſome real Grounds: So that in all likelihood the firſt Inhabitants were ſome of thoſe long-liv'd Men, who flouriſhed near the Flood, and are famous for their robuſt and gygantic Stature.

As a farther Confirmation of our Argument, it may be proper to obſerve, that theſe Weſtern Colonies had left the Eaſt very early, even before the Arts of Spinning, Weaving, Ploughing, the Hatchet, or Letters were invented; for the Greeks relate the Perſons to whoſe Ingenuity they were indebted for their Introduction among them, but who it is likely brought them from the Eaſt. For in the Oriental Countries, before the Deſtruction of *Sodom*, *Abraham* mentions *Thread*; and ſoon after *Rebecca* wore a *Veil:* But in the Weſt, their Demi-Gods and Heroes wore the *Skins of Beaſts*; the *Germans* and Inland *Britains*, in *Cæſar*'s Time, had the ſame Cloathing. How the *Milleſian* Race came by their *Braccans* ſo early as they report their Deſcent into *Ireland*, *viz.* one thouſand three hundred Years before *Chriſt*, about ſeventy Years before the Expedition of the *Argonauts*, above five hundred Years before the Building of *Rome*, is not to be accounted for but by diſpoſing their Journey to *Ireland* much later. For 'tis not conceivable, that the *Celtæ Braccatæ* in *Gallia Narbonenſi* ſhould be skilled in theſe Arts before the *Italians* or *Greeks* well knew how to make Leathern Jerkins. We may farther conclude, that *America* was planted as ſoon, and that by Land: For had they been acquainted with the before-mentioned Arts, they never would have loſt them; for Spinning and the Uſe of the Hatchet were deviſed before any ſort of Shipping or Sails, except Boats hollowed by Fire, ſuch as Cannoes, or Boats made of Twigs covered with Skins, not unlike the *Carroghs*.

But as to the main Strength of the Objection, *viz.* That there could not be ſo many Inhabitants at the Grand Diſperſion as would be ſufficient to people the remoteſt Iſlands; we may form an Anſwer, by conſidering the Account which *Moſes* gives of this remarkable Event in *Gen.* Chap. 10. where he names ſeventy Leaders of Colonies or Nations, and perhaps as many Languages, for ſuch they were. But we are not to imagine, that *Shem*, *Ham*, and *Japhet* had no more Children; for in the next Chapter he particularly reckons up the Poſterity of *Shem*, and farther tells us, that *Arphaxad*, beſides *Selah*, whom he but juſt mentions in the 10th Chap. had Sons and Daughters: The ſame alſo he relates of *Selah* and *Heber*, in Chap. 10. Ver. 32. he ſays, *By theſe were the Nations divided in the Earth after the Flood.* And it is more than probable, that theſe individual Perſons, living to the Age of four or five hundred Years, theſe Companions of the Giant and *Nimrod*, might be found alive in their ſeveral Nations by future Colonies, and occaſion the Fables of Giants, as being the firſt Inhabitants in every Country.

The Number ſeventy God ſeemed to have reſpect to, it being the Number of *Jacob*'s Sons that went down into *Ægypt*. So, *Deut.* xxxii. 8. *When the Moſt High divided to the Nations their Inheritance, when he ſeparated the Sons of* Adam, *he ſet the Bounds of the People, according to the Number of the Children of Iſrael:* So that *Iſrael* ſeemed to be an Epitome of the World. Accordingly he appointed the *Sanhedrim* to conſiſt of ſeventy Elders, and *Chriſt* ordained ſeventy Diſciples for the ſeventy Nations of the World. From hence we may gather, that it was God by his Prophet *Peleg* who allotted each Tongue and Nation their Inheritance, and not as Colonies ſpread when they overſtock'd their Habitations.

That there was a Symmetry and Proportion betwixt the firſt Planters of the World, and the Planters of *Canaan*, will appear from the following Conſideration; *viz.* The *Iſraelites*, when they went to poſſeſs *Canaan*, were ſix hundred thouſand Men, beſides Levites, Women, and Children, who, by the leaſt Allowance, may be reckoned at thrice as many, in all two hundred and forty thouſand; which Number may be reaſonably allowed at the Diſperſion. The *Iſraelites* indeed were ſeventy for two hundred and fifteen Years, and *Noah*'s Sons but three for an hundred and thirty Years: Yet if we conſider, that they lived to four Times their Age, had Children when they were very old, that they had greater Degrees of Health and Strength, and frequently many more Children, all living (for it is recorded as a ſingular Inſtance that *Haran* died before his Father); we may reaſonably conclude from the Hint in the forecited Text, that they were as numerous. But to remove all Objection of Improbability, we will allow them to have no more than twenty

Children in thirty Years, a Time and Number exceeded by many Women in this Age, and which is a Proportion, I am perſuaded, ſhort of the Truth; for I believe they bore Children to a much greater Age; to which may be added, the Multiplication by Twins, and the Practice of Poligamy; allowing however no more, and that they began to bear at twenty Years, in thirty Years the Number of young People will be one hundred and twenty: for three old Couples will beget ſixty, and thoſe born the firſt ten Years will be twenty one Perſons, which by an eaſy Computation will beget ſixty more, in all one hundred and twenty. And thus proceeding for one hundred and thirty Years, the Number will much exceed that I propoſed, which I ſet rather too low. But that nothing I offer may look romantic, I ſhall confine myſelf to Two million four hundred thouſand. And if we reflect on the Increaſe of People in *Abraham*'s Time, it really ſeems as if I had fixed the Number of Mankind much too little: for *Ægypt*, *Syria*, *Canaan*, *Chaldea* and moſt of *Aſia* peopled, many large Kingdoms erected, five Cities in one Plain of *Sodom*, *Aſhur* at the Diviſion able to lead ſo many as to build three large Cities, *Ninus* and *Semiramis*; Armies of a World of People, all ſufficiently prove Mankind had wonderfully increaſed. But to return: Of this Number *Japhet*'s Poſterity, although but fourteen Leaders of ſeventy, may be ſuppoſed $\frac{1}{3}$, if not more, becauſe God promiſed to enlarge *Japhet*; the $\frac{1}{3}$ therefore is eight hundred thouſand. As to the Number of his Poſterity that came into *Europe*, we can only gueſs by the ſeveral Languages or Nations that firſt peopled it, which ſeem to be four; that is, the *Celtick*, who by all Accounts poſſeſſed *France*, *Spain*, *Britain*, and *Ireland*, as their antient Language proves: 2. The *Teutonic*, ſpoke all over *Germany*, *Belgium*, *Sweden*, *Norway*, *Denmark*, and Part of *Poland*: 3. The *Sclavonic*, ſpoken by the *Sarmates* in *Muſcovy*, *Poland*, *Hungary*, and *Tranſilvania*: 4. The *Greek*, in uſe all over *Greece*, *Macedon*, *Italy*, the *Iſles*, *Epirus*, and other Places; for the *Latin* is but a Dialect of the *Greek*. What the antient *Thracians* were, I cannot tell, but poſſibly another Colony: And allowing the Sixtieth Part for *Ireland* of Two hundred, twenty eight thouſand, five hundred and ſixty eight, the $\frac{1}{14}$ of *Japhet*'s Poſterity, the Sum is three thouſand eight hundred and nine, which increaſed to the End of thirty Years, will amount to above thirty thouſand; a Number ſufficient to deſtroy the Woods in their wandering way of living, which was ſomething like the antient *Nomades*. When I allow *Ireland* to be the ſixtieth Part of *Europe*, I mean the antient *Europe*, which was much leſs than the preſent, it being then bounded by a Line drawn from the River *Tanais* to the Gulf of *Trinland*. The reſt of *Japhet*'s Poſterity peopled *Media*, *Aſia the Leſs*, *Scythia*, and perhaps ſome of them paſſed into *America*, as it is likely did ſome of *Shem*'s Deſcendants: For the remaining Part of *Aſia* was too ſmall a Portion for *Shem*, in as much as the Families of *Cham* poſſeſſed Share of *Aſia*. And *Babel* or thereabouts being choſen both at the Creation and after the Flood for the diſperſing of Mankind, it is not in the middle of the habitable Earth, unleſs Part of *America* be added to the Eaſt.

I think it may not be improper in this Place to take notice of two Cuſtoms of the *Iriſh*, not mentioned by our Hiſtorians. The firſt is the burning of Woods and Heath on Mountains; for it is obſervable, they are much more ready to burn a Buſh to look for any thing loſt in it, than to cut it down. This was the Practice of their Fore-fathers the *Celtæ*, according to *Strabo*, who tells us, that the *Celtic* Shepherds, at the Foot of the *Pyrenian* Mountains, ſet the Woods on fire, and that from the great Conflagration it made, the Mountains took their Name.

The other Cuſtom is, the Bleeding their Black Cattle in Summer, in the Mountains, ſometimes twice or thrice, to get their Blood, which having boiled, they uſe as we do Bread, with Butter. From the *Celtæ* I believe proceeded the Cuſtom in the Weſt of eating Blood, which however defended or pleaded for, was always reckoned barbarous and ſavage. *Silius* upbraids the *Concani*, a Nation of the *Celtæ* in *Spain*, and Fore-fathers to the *Concani* in *Ireland* with it.

> *Et qui* Maſſageten, *monſtrans feritate Parentem*,
> *Cornipedis fuſa ſatiaris*, Concane, *vena*.

The Difference is only that he upbraids them with drinking Blood, which we more innocently eat. *Cambden* mentions theſe *Concani* drinking Blood.

I think I have no Reaſon to retract what I have already advanced in relation to the Diſperſion of Mankind at the Flood, but am rather confirmed in my Opinion from the concurrent Teſtimonies of antient Writers and Traditions, who all ſpeak on my Side, altho' Dr. *Wells*, Mr. *Mead*, and Sir *Walter Rawleigh*, are of a different Judgment.

I am very much at a loſs why Mr. *Mead*, in his Rules to judge of the Planting of the World, took no notice of their Languages, for by them were their Nations divided. An Inſtance of which is the Diſpute about the *Ionian* Cities on the Coaſt of *Aſia:* The Queſtion is, whether they were the Stock or Colonies of *Greece. Themiſtocles*, intending to breed Jealouſies in the *Perſian* Fleet, wrote in *Greek* to the *Ionians* at the Watering Places, and *Lutichides* practiſing the like at *Mycale*; prove the *Ionians* ſpoke *Greek*, a Language different from the Inland Country, and diſcovers them to be Strangers, and *Grecian* Colonies, notwithſtanding what theſe three Gentlemen have written to the contrary. Mr. *Mead's* Calculation of ſeven thouſand Men only at the building of *Babel*, muſt be a palpable Miſtake: for if Mankind increaſed no faſter, *Aſia* could not have been ſo well ſtocked with People in *Abraham's* Time; nor is it hardly credible, that Colonies would have reached hither to this Day. But contrary to this, *America* and all the Iſlands and Continents in the *South Sea* were planted, and *Cæſar*, upon his coming into *Gaul* and *Spain*, found thoſe Kingdoms as well peopled as *Italy*, *Greece*, or *Aſia*, and ſays, that in *Britain* he found an infinite Number of People. And not long after his Time the World found *Scandinavia* and the Northern Countries over-ſtocked, and *Scythia* vying for Antiquity in the earlieſt Times, with any Part of the World. So that I muſt beg leave to differ from Mr. *Mead* in this Particular, *viz.* As to the Numbers and Manner of Diſperſion.

But the Difficulty that theſe Authors ſtumble at is this; *viz.* That it is not reaſonable to ſuppoſe Mankind would paſs over the fine Countries of *Aſia*, where, during the Continuance of many Ages, there was Room enough: But the Command of God was expreſs, and the Confuſion of their Languages made their Living together impracticable; ſo that it became neceſſary, as it was requiſite, that they ſhould be ſcatter'd over the Face of the whole Earth, and thereby prevent the Confuſion of Nations.

But what need is there of ſo many far-fetched, and ſome of them improbable, Etymologies to detain the *European* Colonies ſo long in *Aſia*, when they ſend *Phut* without halting into *Mauritania*, which lies as far off as *Spain*, and not ſtop at the ſandy Deſarts of *Lybia*; others into the Heart of *Afric*, ſome into the Cold and Northern *Scythia*, and only the Colonies of *Europe* needed Wings to make ſuch Haſte.

Many Inſtances may be given of Colonies, who derive their Names in a different manner; as *Tyre*, by the Likeneſs of the Word, ſhould ſignify as if the *Tyrians* were deſcended of *Tyrus* the Son of *Japhet*: but it is not ſo, for they were of the Poſterity of *Ham.* So *Havilah* and many other Names, which were common both to *Shem* and *Ham*'s Poſterity.

The Families of *Kittim*, *Dodanim*, *Eliſha*, and *Tyrus*, are not reckoned in *Cyrus*'s Army, nor did they hear the Trumpet ſounded to call them together to deſtroy *Babylon*, as they would certainly have done, had they inhabited the *Leſſer Aſia*, and been number'd in one of thoſe Hoſts, as *Gomer* and all his Bands, *Meſchech* and *Tubal*, *Askenas* and *Togarmah*, actually were.

I am, My LORD,

Your moſt Obedient and Humble Servant,

MAGILLIGAN,
Sept. 14. 1726.

ROBERT INNES.

LETTER V.

Of the General Tides *in the* Atlantic *Ocean.*

My LORD,

I Can hardly conceive, that the Moon can have any Influence on the Tides, by preſſing upon our Atmoſphere, or (if I may be allowed the Word) by Attracting it, for the following Reaſons; *viz.*

1. The Weight of the Air is not in the leaſt affected with it; which may be argued from the Property of Quick-Silver in a Barometer, which neither riſes nor falls with Tides: And there is Reaſon to believe it would as ſoon make the Air ebb and flow, and raiſe Sir *Iſaac Newton*'s Spheroidical Ring in the Air as well as in the Sea, both being Fluids; and the Air meeting with no Interruption from the Land, as the Sea does, ſo neither doth the Barometer riſe and fall with the Courſe of the Moon; notwithſtanding Mr. *Varin*'s Obſervations, That in the South of *Afric* it fell each Day with the Sun, and roſe each Night three or four Lines. But this is accountable from ſome other Principles, and hath little or no Influence on the Tides.

2. Scarce two Places under the ſame Meridian have their Tides at the ſame Time, which is not conceivable if governed by the Influences of the Moon; the farther North the later: ſo that at the *Maderaes* and *Canaries*, on the firſt Day of the Moon it is full Sea at one o' Clock; at Cape St. *Vincent* in *Spain*, at half an hour after two; at Cape *Fineſtre*, at three o' Clock; at Cape *Clear*, on the South of *Ireland*, at half an hour after four; at *Broad Haven*, about five; at the Iſle of *Mull*, later. And it farther obſerved, that Places much differing in Longitude, tho' little in Latitude, have full Sea at the ſame time, as at *Rochell* in *France*, and the Mouth of the River *Pentagoſt* in *Arcadia*; at *Londonderry* in the Offing its full Sea, when at *Strangford* on the Eaſtern Coaſt of *Ireland*, it is Low-Water. But within the Tropics it differs; for on the *African* Shore, on the firſt of the Moon, at one o' Clock 'tis High-Water, when at the Iſland of *Cayen* 'tis Full Sea at four o' Clock in the Afternoon, as Mr. *Kicher* affirms; which, conſidering the Difference of Longitude, is half an hour after ſix at *Suffa*, near the Time of Low Water there.

3. Neither are the higheſt Tides at New or Full Moon, except within the Tropics, on the third Day of her Age at the Height, and no earlier on theſe Coaſts, as others as well as my ſelf have for many Years obſerved, unleſs altered by Storms. Near the Equator at 5. h. 40'. Afternoon, on the *American* Shore, when the Sun hath exerted its whole Force on the *Atlantick* Ocean, and hath had the whole Day to heat it, at that time are the greateſt Tides.

4. Nor can it be ſuppoſed, that the Moon, at ſo great a diſtance as about ſixty S. Diameters of the Earth, and its apparent Diameter being little more than half a Degree, without any *Medium* to convey its Influences, according to the new Principles, which by Lines drawn perpendicular to the Center of the Earth, as all Lines of Gravity are, can preſs upon little more than thirty Miles of Sea, which can never raiſe ſo much Water as to force the Sea out to the Quadrature, and we ſhould have it ebb and flow every four Minutes: For the Principle of Planets gravitating to one another, without a *Medium*, and gravitating to any Lines but perpendicular to the Centers of each, is *gratis dictum*; for Lines of Gravity are not directed as Light and Heat. But what Influence can the Moon, coming to our Meridian in the other Hemiſphere, have to make any Preſſure on our Sea? For tho' the Orbit of the Moon be Ellyptical, muſt therefore our Sea be ſhaped accordingly? This is only the Production of a fine Imagination: For our Atmoſphere is computed to extend only forty or fifty Miles.

5. Some lay a great Streſs on the Diurnal Motion of the Earth, as the Cauſe of the Tides, but I am afraid their Argument will not hold; for if it be as they imagine, why ſhould it not rule the Air in the ſame manner as the Sea, I mean the Air at Land as well as at Sea; for the Trade Winds blow no where but at Sea, and the Coaſts thereof: which is a ſufficient Proof, that it is owing to the Vapours raiſed out of the Sea by the Heat of the Sun, to the rarifying and condenſing of the Air, and not to any Gravity to the Moon or Sun. If the Diurnal Motion did not placidly carry the Air and Sea with it, it would give a Handle for unanſwerable Objections againſt it: And if we ſuppoſe that the Diurnal Motion of the Earth cauſeth the General Eaſterly Wind, how comes it that the Air beyond the *Tropics* do not partake of the like Motion? Or how could there be any Calms even within the Tropics? How can there be contrary Monſoons, and the higheſt Mountains to be freeſt of Wind? No, the Tropic Winds riſe and ſet with the Sun; and as the Sun gets farther North, ſo do the Eaſterly Winds extend to the ſame Point.

6. Some have argued, that the Moon muſt be the Cauſe of the Tides, becauſe we have the greateſt when that Luminary approaches the Earth at New and Full. But this does not hold good, for then the Moon being in the *Perigeum*, would alſo occaſion Spring Tides; which if ſo, we ſhould frequently have thrice in one Moon, that is, when the *Perigeum* falls in with the QuarterMoon; but this never happening, it is plain the nearneſs of that Planet hath no Effect upon the Tides.

7. All Fiſhermen agree, that they perceive no Increaſe or Turning of the Tides until four Days, rarely ſooner, before the Full and Change, and that they are as long in their Decreaſe: If ſo, the higheſt Tides muſt happen, at ſooneſt, on the third Day of the Moon.

8. The Tides do not follow the Inequalities of the Moon's Motion, which, in the ſecond and laſt Quarters, is quicker, and in the third and firſt ſlower; but the Tides are conſtant and equal in their Returns, every Day near 50′ later; from which the Moon varies. The Tides compleat their Courſe twice in the Month, and the Moon but once.

9. The Tides in theſe Seas depend upon a Current, and ſwell from the Weſt, and not on the Moon's Influence; becauſe the farther the Tides run to the Eaſtward, as at the Bottom of the Bay of *Biſcay*, or up Channels, or to the Eaſtward of any Iſlands in theſe Seas, ſo much the later: whereas if the Moon was the Cauſe, the farther Eaſt they would flow the ſooner. Likewiſe a ſmall W.

or S. W. Wind raiſeth the Tides conſiderably, but an E. or N. Wind, altho' we lye open to the North Sea, abates them.

Seeing then there can be no Certainty of the Moon's Influence on the Tides, either on the Air or Sea, which it is viſible the Sun hath on both; let us ſee in what manner the Sun may probably affect it. Mr. *Halley* hath made it appear, that the Sun is the Cauſe of the General Tropic Wind: 'Tis plain that the Winds raiſe the Tides in Storms to five or ſix Feet above the higheſt Springs, much more may a perpetual Wind drive the Sea, and cauſe a continual Current: for Storms ſeldom extend to above an hundred Leagues. Computing therefore the Air in a Storm to run ſixty Feet in a Second of a Minute, and the Tropic Wind to move but twelve Feet; yet, tho' we ſhould look no farther than the narroweſt Place of the *Atlantic* Ocean, which by general Computation is five hundred Leagues: I ſay the Velocity of twelve Feet with a quintuple Weight of Sea, is able to raiſe the Sides on the *American* Shore as high as a Storm raiſeth it above the uſual Height of the Tide. But if we add the Current of all the Seas round the Globe, together with the rarifying the Water, we may give allowance for the ſlower moving of the Trade Wind. The greater the Sea is, the greater the Tides when ſtopt by any Shore, as the Current from the *Pacific Ocean*, when obviated by the Iſland of *Sumatra* throws a mighty Tide into the Bay of *Bengal.*

Beſides the Wind, there are other concurring Cauſes of the Swelling of the Sea, *viz.* The Weight of the Atmoſphere, and the Rarifying the Water; and as the Currents of theſe combine and ſtrike in with the Flood-Water, accordingly the Tides are greater or leſs.

Farther, We are to conſider the *Atlantic* Sea as Water in a Veſſel, toſſed and raiſed on the farther Side, which ſtands not long there, but returns to the near Side, and ſo backwards and forwards even againſt the Motion that diſturbs it; or like a Pendulum, which riſeth near to as great a Height in oppoſition to that Gravity which firſt ſet it a moving. So the Sea being daſhed againſt the *American* Shore, returns to the *African* almoſt with the ſame Velocity it began, againſt the Current of Wind and Sea, which yet by degrees would ſettle in a Stagnation, was it not daily renewed by the Sun.

That the reciprocal Motion of the Sea is of this Nature, appears from hence, *viz.* Becauſe the ſwifteſt Time of the Tide is at half Flood and half Ebb; and as it proceeds to full Sea, the Velocity decreaſeth, and the Waters riſe in Height above the true

Level: for the Gravity of the Waters reſiſt the Velocity of the Swell. The uſual Height of the Tides within the Tropics is five or ſix Feet; the Half of this is the true Level, and the Height the Sun and Winds raiſe the Sea to, except in Spring Tides. So that the Sun is no more but as the Weight in a Clock, which is neceſſary to keep the Pendulum moving and conſtant. But was it the Moon that ruled the Tides, the Current muſt be ſwifteſt when ſhe comes to the Meridian, whereas the ſole Cauſe of this Velocity hath moſt Influence: And farther, it ſhould be full Sea, or at leaſt low Water at ſuch time; but on the contrary, there is not one Place on the Coaſt of this Ocean, except in Channels, from the Equator to ſixty Degrees North Latitude, that is either High Water or Ground Ebb when the Moon is in the Meridian.

I know Sir *Iſaac* would ſalve this, and make the Influence of the Sun the Cauſe of the Tides deviating from the Courſe of the Moon; but in that Caſe all the Shoars on the Ocean would ſwell alike, and the Velocity of the Tides would then be greateſt; whereas in fact it is not ſo, for even at full Sea, when both Luminaries join their Influences, the Tides are ſloweſt. Farther; was it either or both the Luminaries that attracted or preſſed the Sea, the whole Body of Water would be moved; which is contradicted by Sailors, who all know that only the Top of the Water is agitated, to prove which they let down a Pot into the ſtrongeſt Current, a little below the Surface, whereby they try its Velocity. Neither is it the Sun alone, for then it would flow all Day and ebb all Night; no, nor both Luminaries in conjunction, and attracting the ſame way, that force the Tides to follow their Courſe.

Having found the Agents that ſet the Sea a moving, we need not look to the Moon to regulate it; for the Courſe of the Moon is direct and nearly equal. The Tides are reciprocal, vaſtly ſwifter at Half-Flood than at High-Water, and interrupted: For at the Turn of every Tide there is a Stand of near 12′, agreeable to the Laws of *Statics*. This Time, conſumed in caſting the *Æquilibrium*, happening four Times in a Day, makes the whole amount to near 50′ in twenty four Hours, the exact Time of the Return of the Moon to the Meridian, reckoning the mean Motion of the Moon. That there is ſuch a Stand and ſuch an Increaſe of Velocity in the Tides, as is ſuitable to the Deſcent of heavy Bodies, and very conſonant to the Motion of the Pendulum, is very obvious.

The next Thing to be conſider'd is, How it comes to flow preciſely ſix Hours, and ebb exactly as many. The Viciſſitudes of Heat and Cold, of rariſying and condenſing both Air and Water, the different Influence the Sun muſt have in the different Quadratures of its diurnal Motion, muſt ſuitably affect the Sea. This is viſible in the Tropic Wind; for all know, that as the Sun riſeth, ſo doth the Wind: ſo that from nine in the Forenoon to three in the Afternoon, there is a conſtant Trade Wind; from three to nine at Night it is calm; at Night the Condenſation of the Air raiſeth a Breeze, and at three in the Morning the Calms return. Off in the open Sea, it is diſtinguiſhed more by the Degrees of Wind.

Thus therefore on the Day before Full or Change, the Tides on the *American* Shore near the Equator begin to flow at nine in the Forenoon to three in the Afternoon, when the Wind falls. On the firſt Day of the Moon, it is 50′ later: but the Heats then increaſing, and the Current which the Wind riſeth continuing, the Tides are higher, and ſo laſt to the third of the Moon, when the Tides come to the higheſt about five Hours forty Minutes Afternoon. Every Day after this the Tide declines as the Heat of the Sun and Current of the Sea, the Weight of the Air and Wind are contrary to the Flood: For on the 4th Day of the Moon the Tide flows to near ſix Hours and half, fifty Minutes of which Time all the former Cauſes are oppoſite to the Flood, and accordingly cannot riſe to the Height it was the Day before. On the fifth Day it is High-Water at ſeven Hours twenty Minutes, of which Time one Hour forty Minutes, the Cauſes for raiſing the Swell are contrary to the Current, and conſequently muſt be lower, and ſo hold on declining for ſeven Days and an half, until the Day Tide get freſh Aſſiſtance from the Wind and Sun, about four Days before the Change, and then again it increaſeth to the Height of the next Spring's. The regular Change from Wind to Calms four times a Day, and the conſtant Variation of Heat and Cold, modelled by a regular and reciprocal Libration of the Water, produce this Variety in the Tides.

The Tides increaſe mightily about the *Equinoxes*; for the Sun, moving in or near the *Equator*, moves over much more Sea than when near the Tropic of *Cancer*, and accordingly raiſeth more Vapours and a greater Eaſterly Wind, and conſequently higher Tides, and is another Reaſon that the Sun and not the Moon cauſeth the Swelling. For the Moon being in the Equinoxial, makes no difference; but the Tides increaſe and decreaſe, as the Sun approaches or departs from the *Equator*.

So far I think what I have ſaid may be as well defended, and more agreeable to Obſervations, than any Hypotheſis that makes the Moon the chief Agent: And what remains, to give an account of the Tides on this Side of thirty Degrees North Latitude, the old Hypotheſes are very inſufficient to account for; how the Tides are raiſed, much higher the farther North; and the more out of the Sphere of the Moon's Influence: for if the Moon cannot influence the *Mediterranean* Sea, becauſe a little to the Northward of its Courſe, how can it influence theſe Seas; or how can the Swell reach ſo far North as this in ten or twelve Hours, when no ſuch Current is perceived at Sea? for it is certain, that when the Moon changeth, our higheſt Spring Tides are on the third or early the fourth Day, when at the *Equator* it is no ſooner than the third Day.

1. Altho' we have no conſtant Eaſterly Winds, nor any perpetual Current from the Eaſt on our Seas; yet there is a viſible Communication of the ſame Tides, the ſame Increaſe and Decreaſe at the Springs and Equinoxes, the ſame exact Regularity of the Continuance and Standing of the Tides, which I think may rationally be accounted for thus: God hath in great goodneſs placed the Continent of *America*, and the Gulf of *Mexico*, as Stops to turn the Tides Northward, to prevent our Seas from ſtagnating, and other merciful Purpoſes. Accordingly there is a conſtant Setting in of the Sea and Wind through the *Carribee* Iſles into the Bay of *Mexico*, and as conſtant and a mighty Current thro' the Gulf of *Florida* to the North Sea out of it.

2. The Mountains *Andes*, the higheſt and longeſt Ridge of Mountains perhaps in the World, running the whole Length of South *America*, ſtop the Winds, as the Shores do the Current of the Sea, and both are directed to the ſame Courſe; for our South-Weſt Winds upon this Part of the *Atlantic* Sea, betwixt thirty and ſixty Degrees, are as general, and almoſt as conſtant, as the Eaſt Winds within the *Tropics:* Neither are the variable Winds any Argument againſt this, for they extend to a very ſmall Diſtance, even the greateſt Storms ſcarce to an hundred Leagues. And tho' there may be many and frequent Interruptions in ſeveral Spots of the Ocean, yet this does not hinder, but the general Weſt Wind does generally blow, and govern the Motions of this Sea, and ſuch Guſts and Storms are but like a Whirl-Pool in a large River: the Weather after Storms does end and ſettle in the South-Weſt, and there it continues, until ſome new Diſturbance of the Air diverts the Wind, in ſome particular Places, which it may be extends not to twenty Miles, ſometimes not to one Mile: Nay, in any one particular Place upon the Coaſt of this Ocean, far more in the Middle of it, the

Weſterly Winds blow three Quarters of the Year, the Southerly Rains and Storms do end and clear up with the South-Weſt; it is true, ſometimes it veers about, and blows 'till it gets about to the North; but it ſoon dies away there, and never ſettles but in the South-Weſt.

And the Air being a Fluid as well as Water, muſt die, when half of this Air is moving from Eaſt to Weſt; the remainder, like an Eddy in Water, muſt move the contrary Way: and the more for this Reaſon, That it muſt ſupply the rarify'd Air within the Tropics. But this Phænomenon is beſt perceived in the hot Seaſon; in Summer, when the Air is not diſturbed, the South-Weſt Wind duly riſeth about Nine in the Forenoon, and dies away at Three in the Afternoon, the very time of the Tropic Wind. And they that frequent the trade to *Virginia*, tell me, that there is a Current ſets off that Coaſt from the South-Weſt, and Ships are driven to the Eaſtward of their Courſe by it. This I ſuppoſe is occaſioned by the *Florida* Current: This General South-Weſt Wind makes the Voyages to *Virginia* and that Continent very tedious; and ſeveral Seamen, not knowing this, of late carrying Paſſengers from hence, have been in great Danger of famiſhing, thinking to return in eighteen or twenty Days, as they came from thence, but found they took near as many Weeks to perform the Voyage.

As the Sun ſoon paſſeth over the *Atlantic* Ocean, and raiſeth a Wind in his Paſſage, the Impreſſion upon the Water muſt be proportionably ſwift, and the Return of the South-Weſt Wind muſt keep pace; not that either the Wind or the greateſt Storm or Current of the Sea, can in ten times that Space of ſix Hours paſs over the Ocean, but the Sun doth it in leſs Time, and the Impreſſion and Swell he raiſeth upon the Water is as ſwift. This imparted to the North Sea, and aſſiſted by the South-Weſt Wind, ſends the Swell ſoon from the South-Weſt to us. This Impreſſion differs much from the Current, for on the Shores in Tide of Ebb, the Waves will ſwell towards the Shore, againſt both Wind and Tide: up Rivers, the Swell will proceed many Hours after it ebbs at the Mouth of the River; in the River *Garrone*, it flows twelve Hours after the Flood is ſpent, at the Mouth of the Harbour: Nay, at the *Streights* Mouth, it ſwells and falls through in the middle, the Current being always inward. This Impreſſion is of ſufficient Force to affect the Northern Sea, for the Weight of the Water of half the Sea, moved by the Sun and Tropic Wind, is equal to what remains, and the Velocity ſuitable paſſing about forty

Degrees in ſix Hours; no longer is the Swell in paſſing from the *African* to the *American* Shore.

As to the great Difference of the Height of the Tides, it depends on the Situation of the Land and Winds; for the Weſterly being generally more boiſterous than the Tropic, raiſeth our Tides much higher, whereas an Eaſterly or Northerly Wind very much leſſens them. So in the *Engliſh* Channel, and Bay of *Biſcay*, the Tides riſe to a great Height, in the *Garron* to twenty four Feet, in *Briſtol* Channel and at *Leverpool* to a great Height, at *St. Mallows*, as *Du Hamel* tells us, ſometimes to ſixty Feet, many Currents and much Water meeting there; for tho' there is no great Current perceived at Sea, yet the Weight of the Weſtern Ocean is equivalent to force great Currents up Channels, that open to that Sea. At *Strangford* on the Eaſt Coaſt of *Ireland*, there is a ſwift and great Tide, occaſioned by the North and South Tides meeting at *St. John's Point*, near that Place.

There is a great Current round the *Cape of Good Hope*, and along the Coaſt of *Chili* and *Peru*, both of Wind and Water; oocaſioned by the Stop the Continents of *Africa* and *America* give to the Eaſterly Current, which like Rocks lying croſs a River, muſt run up the lower Side of the Rock, to ſupply the Water that hath fallen away; ſo a South Current and Wind ſets along the Coaſt of *Afric*, up to the great Bay of *Guinguia*, and the like along *Chili* and *Peru* to *Panama*; to the North of *Scotland*, the Sea at *Schetland* and the Coaſt of *Norway*, ſeems to be ruled in their Currents (tho' not in the Swell and Tides) by the many Rivers and melted Snows, that run into the Northern Seas; for one that frequented thoſe Seas, aſſured me, that during the Months of *July*, *Auguſt*, *September*, and *October*, there is a Current ſets Northward conſtantly at three Knots an Hour, its likely when the Rivers are dryeſt; but as ſoon as the Winter Rains return, the Current ſets Southward. The *Baltic* Sea is ruled in the ſame manner by the Rivers that run into it.

As to the *Mediterranean*, there is a Current ſets conſtantly in at the Streights Mouth, but ſo narrow, that it is not ſufficient to impart the Swell to that large Sea; and accordingly no Tide but what is near the *Streight*'s Mouth. Beſides, there is no general and conſtant Wind on that Sea; and farther, there is another Current from the *Euxine* Sea, oppoſite to that at *Gibraltar*, which if nothing elſe, yet this would deſtroy the Tide. What Tide may be in the *Adriatic*, needs farther Obſervations of the Currents and Winds, and a more particular Account of thoſe Tides, before any Conjectures can be made of them; only both Currents, *viz.* from *Gibraltar* and *Helleſpont*, ſeem to meet near *Sicily*, and their Force to be directed up the *Adriatic*, and the Waters to be raiſed higher or lower, as the Tides are at *Gibraltar*.

All Bays and Seas in danger of being overcharged with Water, are guarded by Streights at the Entrance; as the *Red Sea*, *Mediterranean*, *Baltick*, and *Hudſon*'s Bay: or by Iſlands, as *Bengall* and the Bay of *Mexico.* This Conjecture of an Eddy of the Wind and Sea ſeems to be ſtrengthen'd by a Current of Wind and Sea from the North, that runs along the Coaſt of *Afric*, from the *Streights* Mouth to the Tropic Wind all Summer.

To conclude, This Eddy of the Wind and Water ſeems to rule the Tides on this Side the Tropics, and muſt keep pace with the Tides within the Tropics, as a Shadow neceſſarily accompanies the Body.

Since the Writing of this, I had an Opportunity to obſerve the Tides, at two ſeveral Springs; at the Firſt the Moon was at Full on *Friday* the 24th of *February*, 172$\frac{6}{7}$. the higheſt Tide was on *Monday* in the Forenoon, being the fourth Day: the Second was at New Moon, on *Saturday* the 2d of *March*; I never ſaw calmer or fairer Weather at ſuch a time ſo near the Equinox in this Country, and then the higheſt Tide was on *Monday* Afternoon, being late the third Day of the Moon.

I am, My LORD,

Your moſt Obedient and Humble Servant,

MAGILLIGAN,
March 1726-7.

ROBERT INNES.

LETTER VI.

Of GRAVITY *and Continuation of Motion.*

My LORD,

IF I miſtake not, *Gravity* hath been given up as an occult Quality and Firſt Principle imprinted on Bodies by our wiſe and good Creator, and as one expreſſed it, *We would need another Senſe to know it.* But conſidering the many Modifications and Variations of this Quality in the ſame Body, according to the *Medium* it moves in, lighter in Water than in Air; and in as much as ſome Bodies cannot be called relatively heavy in any *Medium*, but are light even in the Air; and eſpecially if we reflect on the Acceleration of Motion in the Deſcent of heavy Bodies, and the equal Deſcent of a Feather and Lead in the Air-Pump; the Conſequence is, That what can be thus diminiſhed and increaſed by external Cauſes, altho' accelerated to above an hundred Times the Swiftneſs, muſt be external: For that which can give it ten Parts of Velocity, is able to impart to it one; and that which can give it Continuity and Increaſe, could give it a Beginning. And farther, altho' animate Beings have a Power to move themſelves, and direct that Motion; yet Things inanimate cannot be ſuppoſed to govern their Motions ſo regularly and conſtantly, but need ſome other Force. I am therefore inclined to believe there may be more probable Cauſes aſſigned than any I have yet ſeen.

Gaſſendus's Reaſon for Gravity, taken from the magnetic Power of the Earth, is not at all ſatisfactory; becauſe this magnetic Power is exerciſed on nothing but Iron, or on ſomething that partakes of its Nature; attracts light Bodies moſt eaſily, which is contrary to the Nature of Gravity; neither is the Direction of the Magnet direct, but towards the Poles; nor are the *Electrical Effluvia* leſs liable to almoſt the ſame Objections.

Nor is the Opinion of *Carteſius*, and of thoſe that illuſtrate it, much more ſignificant; which is, That the vortiginous Motion of the *Ætheria Materia* thruſts every Thing that is not fit to follow its Rapidity, towards the Center; but that is in a ſpiral Motion, and the Deſcent of heavy Bodies is in a ſtrait Line. Again, If the circular Motion be very rapid and ſwift, ſuch as the *Ætheria Materia* is, the Body does not deſcend, but is thrown to the Edges of the Veſſel. Nor is the heavy Body, thus deſcending, directed to the Center, but to the loweſt Part of the Axis of this Motion; and purſuant thereto, heavy Bodies by the like Direction would not deſcend perpendicularly, but move in a Line Parallel to the Axis of the Earth. Neither can we rationally ſuppoſe, without firſt allowing Gravity to Bodies, that the greateſt Bulk is as uncapable of Swiftneſs as the ſmalleſt Atom: So that the Cauſe of Gravitation muſt be ſought for elſe where.

Others ſuppoſe the *Materia Secunda* to be of immenſe Weight. This is alſo begging the Queſtion; for from whence ſhould the Gravity of it proceed? Nor is Elaſticity, or any other Motion of the Air ſufficient to ſolve this Difficulty, becauſe it ſuppoſeth, as *prior*, the Gravity of the Body to preſs the Air: But all Motion from Elaſticity dies away, ſo far is it from being accelerated.

As I reflected on theſe Reaſonings, I began to look about for ſuch a Mover as might anſwer theſe Difficulties, and upon the ſtricteſt Enquiry, I believe there could be no other than a Perpetual Mover. In purſuance of which Perſuaſion in my ſelf, I began to conſider what kind of Motion GOD at firſt imprinted on the Material World, and upon conſulting the Oracles of Truth, I found there what I believe will ſolve this and other difficult *Phænomena* in Nature. And I think this may be well added to the other Marks of the Spirit of Truth inditing the Holy Scriptures, *viz.* That there is nothing in them contrary to the ſtricteſt Philoſophy, tho' written by Perſons in different Ages, and various Capacities, and of whom few can be ſuppoſed skilled in Philoſophical Learning; nor could any thing preſerve them from ſtumbling on Abſurdities but the Spirit of God. I ſuppoſe every Perſon will make allowance for figurative Speeches.

Had Mr. *Des Cartes* conſulted the 1ſt Chapter of *Geneſis*, I am perſuaded he would not have formed his *Materia Prima*, by rubbing off the ſolid cubical Part, into which he ſuppoſes the World to be divided, by the circular Motion of theſe Parts: for *Moſes* calls it expreſsly *Maim*, which ſignifies a Fluid in general, not Waters: Nor was it ſuch a Mud as *Thales* or *Ovid* ſuppoſe, but ſome Fluid not near ſo groſs as Air; for it is incredible that all the Stars and Planets reduced to their firſt Conſiſtency, and to fill up the Space the World contains, could be ſo groſs as Air. Let us examine our own *Vortex*, wherein are ſeventeen Planets and Satellites, all that are as yet known; let us alſo ſuppoſe each of them of the Bigneſs of the Earth, and Conſiſtency of Gold; which is as near to Air as 16000 to 1. which + by 17. makes 272.000 times the Bulk of the Earth in the Air. But the Semi-Diameter of the Orbit of *Saturn* is near 2.20.000 the Semi-diameter of the Earth. Now, Spheres are in triple Ratio of their Diameters, or as the Cubes of their Diameters, which is more Room than if the Air was rarified near 3.000.000.000.000.000 times could fill: So that the firſt Matter muſt have been near three thouſand millions of millions rarer than Air.

The firſt kind of Motion that is mentioned, is that peculiar to Light; and ſuch a Motion is well adapted to divide and ſeparate the Particles of ſuch a Fluid into ſuch Orbs as GOD directed.

The Motion of Light is the ſame with Fire; and the Difference is only that the Subject Matter of Fire is groſs, as that of Light is inconceivably pure and more penetrating than Fire, fit for ſeparating all Species of Bodies: For when the groſſer Light is collected by a Burning-Glaſs, it is able to diſſolve or ſeparate Metals. There is alſo a middle Flame, ſuch as is contained in Meteors, and the *Phoſphorus*, which is eaſily increaſed to Fire. This Motion is immenſely active, as is ſeen in the Darting of Light in a Moment from the Sun and Stars: Its Violence and Force in Lightning and Earthquakes is likewiſe prodigious; it does not fade and die like other Motions, but continues and increaſes, ſo that a Spark is eaſily blown up into a great Flame. The Laws aſſigned to other Projectiles, will not anſwer the Compoſition of Light and Fire; no Rubs or Frictions by impinging on its Fuel, leſſens its Vigour: It is a perpetual Mover, and reſtleſs; it conſiſts in a reiterating and vibrating Motion, from a large Baſis to a Point; all or moſt of the Force is directed to that Point, and yet the Direction is eaſily changed: So that Light can be refracted and reflected, diſperſed and collected. Beſides this Vibration, Light and Fire have a circular Motion: The Diurnal Motion of the Earth or Heavens is not comparable to the Violence and Swiftneſs of Light.

The Earth, Sun, Moon and Stars being ſurrounded by ſuch an Orb of Light, and a Communication being kept up by this ſubtle Matter, each Orb of Light directing its Vibrations to its own Center, yet very ſuſceptible of Impreſſions from other Orbs, and ours eſpecially from the Sun, which vaſt Fire influences our Vibrations and conſequently our Light and Heat; but not being in the ſame Direction, weakens the perpendicular Direction, and ſo of courſe the Weight of Bodies: For the *Pendulum* moves ſlower in the Torrid Zone, where the Force of the Direction from the Sun is ſtrongeſt; and the Mercury riſes duly every Night four Lines, as the Force of the oblique Direction abates. In theſe Parts, the Strength of the Sun's Direction is ſo weak, that it makes no ſenſible Difference, tho' the *Pendulum* may move ſwifter nearer the Poles. Certain it is, that the North Wind abates the Heat and Force of the Sun, and raiſeth the Mercury: This croſs Direction occaſions a tumultuary Motion in the Air and Æther, and cauſeth Diſſolution and Separation, and is oppoſite to the perpendicular Direction, which tends to promote Solidity and Firmneſs.

This brings me to a Conſideration of that hard and knotty Point, viz. *The Continuation of Motion*, which may be thus explained and reſolved: As the Force makes the Impreſſion and Direction, the Æther is ſet a vibrating in the ſame Direction, if obliquely, the frequent Vibrations of the Æther force it on, 'till by degrees it is gradually maſtered by the general perpendicular Direction: The Air alſo very much impedes this Motion. That this ſubtle Æther is capable of impelling Bodies with ſuch Violence, is plain from Lightning; wherein nothing but the Velocity of the Flame is able to overturn the weightieſt Edifices. The ſame Æther, altho' exceeding ſubtle, yet is capable of forcing the heavieſt Bodies into Motion, not excepting the Planets themſelves, and thruſt towards the Earth every thing within its Sphere; and notwithſtanding its Subſtance is ſo inconceivably pure, that it does not affect our Senſes or irritate the Nerves, yet are its Effects in Nature admirable and ſurprizing, ſuch as its magnetic Virtues, the Fluidity of Liquors, the ſwift Conveyance of Light are evident Inſtances of a ſuitable Velocity and Force anſwerable to theſe Difficulties.

In like manner is the Acceleration of Motion in the Deſcent of heavy Bodies, whereas an oblique Motion through the Air decays. This argues for a perpendicular Force; for the Reſiſtance of the Medium, *viz.* the Air, is much the ſame in both. The perpendicular Direction of Vibrations is beyond Conception quick and ſhort; every new Impulſe from theſe Vibrations adds to the Velocity of the deſcending Body. The continued Additions of theſe Vibrations add to the Gravity or Velocity: And that it is continued Addition of new Forces, and not a conſtant and equal Preſſure of the ſame Force, is manifeſt from the Acceleration of this Motion.

Heat, Light, and Flame, are increaſed proportionably to the Groſſneſs of Matter put into a due Motion: For our common Fires are hotter than the Rays of the Sun, becauſe the Fewel is groſſer than Air; and the groſſer Air in Valleys, for the ſame Reaſon is hotter than the Air on Mountain-Tops: and in all likelihood, if we could aſcend higher, we ſhould perceive no Heat from the Sun. If therefore ſo ſmall a Diſtance as the Height of a Mountain can make ſuch a Difference, it muſt neceſſarily be occaſioned by the Groſſneſs of the lower Air (if I may be allowed the Expreſſion) which is kindled and ſet on fire. To this we may likewiſe add the Experiment of the *French* Academy, in ſetting a red hot Bell round the Receiver of an Air-Pump, which it was impoſſible could raiſe ſo much Heat as to melt Butter within the Receiver, when the groſs Air was pumped out. The Apprehenſion therefore of the Earth's too great Danger by any nearer Approach to the Sun, is wholly fanciful: Nor is *Mercury* in more Danger to be ſcorched than *Saturn*, nor has *Jupiter* leſs Heat than the *Earth*. The whole Difference lies in the Groſſneſs of their ſeveral Atmoſpheres. Theſe Reaſonings induce me to believe, that the Brightneſs and Colour of the Planets depend upon the Nature of their Atmoſpheres. I am aware that the many Reflections from the Sides of Mountains, and Refractions through the Clouds, collect the Sun-beams, and increaſe the Heat. Altho' this Light or Æther affects not the human Senſes or the Eye, yet the more curious Structure of the Eyes of ſeveral Creatures are enlighten'd by it in the darkeſt Nights and Rooms.

Altho' the Direction of the Sun-beams to any one Place on the Earth (except where the Sun is in the *Zenith*) is oblique, yet conſider'd in whole with reſpect to the Terreſtial Globe, the Solar Beams are direct, and, agreeable thereto, repell the Earth; not that it gravitates towards the Sun, for that is not probable, but ſuch a Force from the Sun is demonſtrable from the Deſcent of heavy Bodies amidſt the Force of the ſolar Rays. Again, Theſe Rays move from the Sun, and are reflected back from the Earth, which muſt ſuppoſe a Motion and Force. This Impulſe from the Sun may ſerve to anſwer for the Irregularities of the Planet, better than a Multiplicity of fanciful Circles: As thus; When the Moon is in Conjunction, the Direction of this Force inclines to the Earth, and preſſeth the Moon towards it; but when in Oppoſition, then is the Earth forced in a Tendency towards the Moon: But at the Quadratures, the Direction moves to ſeparate them. This, it is true, does not agree with the new Hypotheſis, *viz.* That every Planet gravitates towards the Sun or Center. But the Difficulty of explaining how the Earth and Moon approach each other at Conjunction and Oppoſition, is Reaſon enough to reject ſuch a Notion. But more of this in another Place.

Neither does our Manner of Reaſoning agree with thoſe who will have all circular Motion to be compounded of one Line direct on the Tangent, and the other of an univerſal Gravity. But I cannot apprehend why a Circular Motion may not be ſimple and natural: For, really to ſuppoſe ſuch a direct Force, is to ſuppoſe it infinitely varied in one Circulation of a Planet, and the Cauſe of ſuch a direct Force as various; which, in my Opinion, is the harſher Suppoſition. However, be that as it will, if the Motions of the Planets muſt be compounded, then this Impreſſion from the Sun is to the Direct Motion of the Planet (which may be ſuppoſed on the Subtenſe of an Arch) as the Verted Sine is to the Right Sine. But we ſee ſuch a Circular Motion in Flame, without any Gravity to a Center: Nor is it leſs evident to me, that all Motions in a direct Line, except thoſe of Gravity, are forced and unnatural.

To conclude; We are ſure of ſuch a vibrating Motion and Force in Light, and need not look into occult Qualities for the Cauſes of Gravity.

P. S. I am very glad that in the foregoing Arguments I have hit on the ſame Thoughts with Sir *Iſaac Newton*; and could have wiſhed he had deſcended to conſider the Nature of Gravity, which, he thought it not impoſſible, was lodged in ſuch a ſubtle Spirit of great Activity. So Mr. *Pemberton* gives an Account of his Opinion in a Book which I have lately ſeen.

Sir *Iſaac*, in his incomparable Treatiſe on *Light*, placeth the Difference of Colours originally in the Rays, and he is certainly right; for the exquiſite Frame of the Eye is variouſly affected, and repreſents a Variety of Colours, according to the Diverſity of the reciprocal Vibrations of the Rays; which Diverſity muſt originally proceed from the Sun, as the different Matter in the Sun, inflamed, doth impart different and various Impreſſions and Vibrations to the ſubtle Æther, which in a Moment conveys to the Eye the ſame Impreſſion; juſt as Diverſity of Sounds are brought to the Ear, in a like Variety of the tremulous and undulating Motion of the Air. The Magnitude of Bodies is repreſented by the Diverſity of Angles by which the Rays enter the Pupil of the Eye; but Colours have their Dependance upon the Diverſity of Vibrations.

I am, My LORD,

Your moſt Obedient and Humble Servant,

MAGILLIGAN,
Feb.12. 1726-7.

ROBERT INNES.

LETTER VII.

Of the LOAD-STONE.

My LORD,

THE old and trite Hypotheſis for the Solution of the ſtrange Phænomena of the *Magnet*, having ſatisfied no body, eſpecially ſince the new Difficulty has been taken notice of, *viz.* The altering its Declination yearly and regularly to the Weſtward, one Degree in ſix Years, as Mr. *Halley* computes it; which I did not apprehend could proceed from the ſudden Stoppage of Iron Mines, and the Opening of others in the Bowels of the Earth: neither can I imagine why ſuch *Effluvia* ſhould conſtantly proceed from the North, and its Collatories more than from any other Quarter; nor how *Effluvia* ſhould get through ſo much Ice and Snow, or over the wide Expance of the Ocean, did it proceed from Mines, or from the Earth's emitting Exhalations ſo vigorouſly from the North, and not rather from the Torrid Zone. I ſhould rather ſuſpect ſuch Exhalations of ſo ſubtle and violent a Motion, if from the Bowels of the Earth, were to be raiſed by Heat, and ſtopped by Froſt and Ice. I ſhall therefore quit that Thought, and apply my ſelf to find out *Effluvia* in the North of an univerſal Influence, occaſioned by Cold. This I thought was more properly to be looked for in the Air than in the deep Receſſes of the Earth; nor will I ſearch occult Qualities for the Cauſes of *Phænomena*; or build my Reaſons on Conjectures, when better Evidence may be had.

The Properties of the *Magnet* are known, and muſt have a Cauſe exceeding ſubtle and active to exert its Force, altho' Wood and Glaſs intervene: Neither is it ſo ſubtle as the Cauſe of Gravity; for it does not in the leaſt affect that Quality. Its Motion is likewiſe from North to South, or near it: It muſt alſo alter its Poſition to anſwer the Declination of the Needle. And laſtly, it muſt be a General Cauſe to affect every Place on the Surface of the Earth.

Among other Reflections of this Sort, I endeavoured to find out ſome Properties of Steel, that might give me light in this Enquiry; (for the Load-Stone is much of the ſame Nature, for it is obſerved that the fineſt Steel is made of it, and that the Load-Stone is found in Iron Mines): I examined particularly what manner of Motion that ſubtle Matter might partake of by the Touch of the Load-Stone. Of all Metals, Steel only in the Melting emits a thouſand Flaſhes and Coruſcations, and a more violent and quick Stroke than the Touch of the Load-Stone, ſtrikes Fire out of it, nor is ſcarce any thing ſolid ſo eaſily ſtruck into Fire. And if the groſſer Parts of Steel be ſo eaſily inflamed, we may rationally ſuppoſe, that the more ſubtle *Effluvia* are ſet into a like Motion by the Rubbing of the Load-Stone: And as the Quality of this Motion in Steel, when on fire, is reiterated, flaſhes, ſo it is highly probable the *Materia Magnetica* moves in the like Flaſhing.

I am the more confirmed in this by the Experiment of a Rod of Steel heated to near melting, which if perpendicularly quenched in Water, receives the Magnetic Virtue: For the groſſer and external Parts being ſuddenly ſtopped and kept in the ſame State they were in when vibrating in the Fire, the internal and more ſubtle have the ſame Paſſages to vibrate in, preſerv'd; and being a more ſubtle Fire, needs the perpendicular Poſition of the Rod to aſcend perpendicularly in. The lower Part being that where the Vibration begins, muſt neceſſarily be ſet to the North to receive the *Materia Magnetica* from thence; which find no Entrance at the Top of the Rod, becauſe it is contrary to the Vibrations of the *Effluvia Magnetica* in it. We are not therefore to look for the Solution of this Property of the *Materia Magnetica* from the Shape of the Particles or the Pores, but from the Direction and Nature of the Motion of them: For groſſer Fumes can aſcend up a Flame, but not deſcend into it, becauſe the main Force of the Flaſhing is one way. It is not to be imagined, that the Pores of a Knife or Needle ſhould be all altered with the Rub of a Load-Stone, and as eaſily reſtored by drawing the Stone the contrary Way: No, this is not to be ſuppoſed, but rather that the Vibrations can be ſet a going in that Direction, and again as readily altered: As by a ſmall Stroke on a large Bell vibrates the whole Body of Metal, by another Touch the firſt Vibration is ſtopt, and a new one begun.

All Electrical Bodies are likewiſe to be thus ſet a vibrating by ſwiftly rubbing them before they have the Power of Attraction. The Diamond which Mr. *Bayle* mentions King *Charles* the IId had, was Electrical, and ſet forth, when rubbed, ſuch Vibrations and Flaſhes, and ſometimes Sparks. There are divers Sorts of Stone, which, when ſtruck on one another, produce a faint Light: It is therefore only ſuppoſing the Load-Stone or Steel fitter for ſuch Vibration, and eaſily conceived how it can attract a greater Weight

than

than Amber. How a vibrating Flame can attract, is another Queſtion foreign to my preſent Purpoſe, however I ſhall juſt mention my Thoughts upon it, and then proceed. It may do it theſe two Ways: Firſt by rarifying the Air, Straws, and ſuch light Things, are driven towards the Amber by the ambient Air: And Secondly, all Bodies whatſoever have an Atmoſphere, as may be ſeen in Electrical and Aromatic Bodies, round which theſe *Effluvia* circulate and draw in ſuch Things as are within their Spheres, and ſuited for ſuch *Effluvia* to circulate in. Almoſt all Fluids, ſuch as Quick-Silver and Water, attract Globules of their Kind to them, if within a certain Diſtance. This ſeems to be the Caſe of the Load-Stone.

And if any ſhould object, that a Globule of Water attracts another, not ſo much by the Vibration of the *Effluvia*, as by ſome other Method, is what I can by no means allow: For Water in the Air-Pump, when the groſſer Vapour is evaporated, by ſtriking the Bottom of the Pump, throws out ſuch faint Flaſhes; nor is it unlikely that their Fluidity is occaſioned by ſuch vibrating Particles, which, when ſtopped in their Movement by Cold or other Cauſes, the Water is made ſolid, notwithſtanding the Lubricity of its Parts, in which it is generally thought their Fluidity conſiſts.

But to purſue my Deſign; The ſubtle Matter that is perpetually paſſing through the minuteſt Pores of Bodies, that agitates them, and makes a kind of Atmoſphere about 'em, altho' in many Things it may differ; and foraſmuch as it partakes of the Nature of the Body it moves in, and that ſuch *Effluvia* have different Qualities, yet in theſe two they ſeem unanimouſly to agree, In the vibrating Motion, and its unctuous or oily Quality: For the groſſer Oils are eaſily inflamed, give a Gloſs to ſome and Tranſparency to others; and the volatile and oily Exhalation in the Air, add a Luſtre to it, and gives it the neareſt Reſemblance of any thing to Fire.

As therefore the perpetual vibrating of this Matter one way, hinders all *Effluvia* to paſs through it, except in the ſame Current and Channel; ſo the Circulation of each *Effluvium* draws Iron nearer the Load-Stone, juſt as a Whirl-pool in Water drives every thing within its Verge to the Center: Or perhaps there may be a Heating of the Air, which is too ſubtle for the Perception of our Senſes; or it may be a general Concurrence of all theſe Cauſes that produces theſe *Phænomena*.

Farther; Let us conſider our Air as a Medley or Compound of all Sorts of Vapours and Exhalations, and that this Atmoſphere moves not from North to South, at leaſt it is ſuſpected to move Parallel to the *Equator:* But altho' we ſhould ſuppoſe it ſo to move along with the Earth in its Diurnal Motion, yet we feel it move by Winds and Storms from contrary Points. The Magnetic Virtue is not therefore placed in the common Air, nor are the Effects of the Load-ſtone hindered or obſtructed by it. This Virtue conſiſts in a much more ſubtle Matter.

Near the North Pole, moſt of the Exhalations are forced down to the Earth by the Principle of Gravity, and becauſe the Influence of the Sun, which is neceſſary to attenuate and keep them afloat, is wanting in thoſe frozen Climates, the Cold is the moſt vigorouſly reſiſted by the volatile and oily Particles, which are not to be congealed. Theſe ſubtle Exhalations are much of the Nature of Fire, are eaſieſt converted into Flame, are as inflamable as the *Phoſphorus*, and always appear in the ſame vibrating Motion: Therefore a great Part of the Atmoſphere in the North muſt be of this Nature; and that it is ſo, the common Conſent of all Voyagers that have been in thoſe Seas jointly teſtify, that ſuch a Light is continually ſeen when not obſcured by the Sun-beams. And there is ſo great a Quantity of this Vapour that of late Years it is ſeen almoſt the whole Winter with us in the fifty fifth Degree North Latitude, when it is calm or froſty Weather. It vibrates like Fire and darts with great Swiftneſs, and generally ſpreads itſelf over one half of the Hemiſphere. Sometimes I have ſeen it ſettle in a vaſt and bright Arch: That its Vibrations reach us is plain, by the Light it affords, which is little leſs than that of the Moon; and by the Storms which commonly follow.

This Meteor and its Vibrations, together with the vaſt Quantity and Conſtancy of it, are all viſible Cauſes of an active and ſubtle Motion, with a Direction from the North, and very like the Motion of the *Ma. Magnet.* Is there not therefore more Reaſon to attribute the Direction of the Needle to this Meteor, than to a Cauſe ſo remote, that it has no Reaſon or Probability to ſupport it. The Declination of the Needle follows the Declination of this Meteor: Every body is ſenſible of its late Appearance to us; whereas formerly it was ſeldom ſeen: All our Accounts of *Greenland* placed it in the North, but now it ſhows itſelf N. N. W. and declines to the Weſtward. I will here, with ſubmiſſion, add a farther Conjecture, *viz.* That poſſibly the Ring about *Saturn*, and the Tails of Comets may be of the ſame Nature, that is, all of them a thin Vapour, and ſo tenuous, that the Stars may be ſeen through them; and that the Tail of a Comet is ſometimes viſible, at other times not, and ſometimes bearded, juſt as the Situation of the Sun, with reſpect to his Beams, is poſited to obſtruct ſuch a Light; nor am I certain but the Earth may appear to an Eye in another Planet as Comets do to us, ſometimes hid with Vapours and Clouds, at other times with a Tail or without, as the Sun approaches to or departs from the Poles.

To this belongs the Variation of the Needle, particularly upon this Ocean; for the farther Weſt, the greater the Variation, ſo far as to twenty Degrees on the North Coaſt of *America*, which is cauſed by the great Difference of the Cold that reigns on that Shore: So that Froſts and Snows are intenſer there in forty Degrees North Latitude, than in *Europe* in fifty Degrees. This, by my Hypotheſis, muſt occaſion the North Light to extend farther on that Coaſt than in *Europe*, as of late Years it has done here; and likewiſe affect the Declination of the Needle. I ſhould be exceedingly pleaſed, if any of the Members of the *Royal Society*, or ſome other able Perſons, would apply themſelves to examine more ſtrictly into the Declination of the Needle, and the Appearance of this Meteor in the North-Eaſt of *Poland* and *Moſcovy*, where the Colds are very intenſe.

By what I have already offered, I think a more certain Power is aſſigned to the North for its Influence on our Atmoſphere, in the Direction and Declination of the Needle: for this Meteor aſcends perpendicularly from the Horizon out of a dark Cloud, and when it is raiſed high enough out of the groſs Air, ſhoots in an Arch to the oppoſite Point of the Compaſs: If the Meteor is advanced farther South, it muſt vary the Needle. Other Meteors, ſuch as Lightning in Thunder, and falling Stars, dart obliquely, and generally downwards. The Trembling of the Needle is cauſed by the tremulous and reciprocal vibrating of this Meteor, and that very unequally; ſuch Motion is viſible in the Northern Light.

As to the Inclination of the Needle, the old Figures and Reaſons will anſwer the one as well as the other, and the better for our Hypotheſis, in that they who maintain the old one can give no good account how the *Materia Magnetica* ſhould aſcend perpendicular at the Poles, whereas the Meteor we are now ſpeaking of doth ſo; which I fancy may be aptly enough compared to the Setling of Liquors. I have before ſpoken to the Communicative Quality only, when the *Materia Magnetica* is ſet a vibrating. The General Influence of the ſame Motion in our Atmoſphere preſerves it, but a contrary Situation deſtroys it. The Ruggedneſs of the Load-Stone retains this Virtue better than Steel, and the Unpliableneſs of Steel better than Iron.

Having before in this Diſcourſe aſſigned two Reaſons for an attractive Quality in the Load-ſtone, but it being in that place foreign to my Purpoſe, I ſhall here purſue and finiſh the ſame Argument, and ſhew how the Attractive Quality may be better accounted for by the reciprocal Vibration of the *Materia Magnetica.* We ſee one Load-Stone often propel another, when the Pores and Paſſages do not anſwer, and when they do, they attract one another; or rather, when the Vibrations in the two Load-Stones are oppoſite in their Directions, they repel one another; but when directed the ſame Way, the *Materia Magnetica* in both unites, like the reciprocal Vibration of the Air in Sounds. Thus in an Octave, when the Times of the different Vibrations exactly hit, the Undulation joins and makes but one Sound and a Symphony; whereas if the Undulations jar, it ſtops and ſpoils both Sounds, and occaſions a Diſcord. Nay, in larger Violins, the Octave Undulation of one String will move a Paper that is laid on another. Now, in the Return of the Vibration, both *Effluvia* in the Magnets being united, muſt draw them into one Sphere, and conſequently into one Center, ſo as that thoſe Parts join that beſt ſuit with the Circulation of the *Effluvia.* Two Flames, when near, will thus unite. There is a Coherency in the Parts even of Flame, as alſo in the *Magnetica Effluvia*, and a Coherency to the Magnet; whether it conſiſts in a Viſcuoſity, ſuch as we have ſeen in Oil, or another Property, is no mattter: but the Magnet affects not every body from the Diſagreement of Pores or Vibrations, or the Difference of *Effluvia.* This makes it appear, that the Attraction is not performed by the groſſer Parts.

I am, My LORD,

Your moſt Obedient and Humble Servant,

ROBERT INNES.

LET-

LETTER VIII.

Of the Syſtem of the WORLD.

My LORD,

MY Deſign in this Diſcourſe is to clear Aſtronomy of the *Incredible:* Not that I think my ſelf capable of adding to the great Improvements already made in this Science by the extraordinary Induſtry, Learning, and Capacity of ſeveral eminent Perſons, but more particularly by Sir *Iſaac Newton.* But upon reading their Philoſophy and Aſtronomy, I find ſeveral Things either above the Reach of my Underſtanding, or, what at leaſt needs a fuller Explication. With due Deference therefore to ſuperior Judgments, I ſhall propoſe my Objections, and give my Thoughts on this Subject, which I ſhall leave to the Learned to cenſure and correct.

To argue from the Moral Reaſons for making the Sun or the Earth the Center of the World, in my Opinion is weak; and the Arguments from Scripture are ſufficiently anſwered by the *Copernicans.* Neither are the common Reaſons of any Weight deſigned to prove the Earth more than other Planets immovable: Nor is the *Copernican* Reaſon for placing the Sun in the Center of more Value, becauſe of the Fitneſs of the Place for communicating Light and Heat to the Planets: For I look upon the Sun's moving in ſo large an Orbit fitter for this purpoſe, as alſo to cauſe the great Alterations in the Motions of them. And farther, the Communication of Light and Heat is ſo quick, and loſeth ſo little of its Force, that the Semidiameter of the Sun's Orbit cauſeth little or no Difference. The Reaſons I ſhall produce ſhall be moſtly Aſtronomical, and ſhall inſiſt chiefly on the Forces neceſſary to keep the Celeſtial Bodies in their Orbits; and that the Centripetal and Centrifugal Forces are, I humbly conceive, meerly imaginary, without any good Reaſons to ſupport the Hypotheſis.

The Velocity of the Diurnal Motion of the Heavens in the *Ptolomaic* Syſtem is incredible, I do not ſay impoſſible: For a greater Velocity can be aſſigned, *viz.* The almoſt inſtantaneous Motion of Light; and in the New Syſtem it muſt be acknowledged, that *Jupiter* moves round its Axis at no leſs a rate than about thirty eight thouſand Miles an Hour, his firſt Satellite at a greater

Velocity. Now although this is not comparable to the Motions of *Ptolomy*'s Firmament, yet it is not much more difficult to conceive the Diurnal Motions of the Heavens, than to imagine a vaſt Satellite to move about ſixty five thouſand Miles in an Hour. But the New Syſtem is liable to the ſame Difficulties, as to the incredible Velocity of the Heavens: For the Stars at an indefinite Diſtance, if they move, muſt move ſwifter than *Ptolomy*'s Firmament. The *Copernican* Syſtem was liable to the ſame Objection, until the Great Sir *Iſaac Newton* transferred all Motion from the Fixed Stars to the Earth, made them immovable, at leaſt as to their Circulation round the Earth, and invented the Spheroidical Figure of the Earth to anſwer this Difficulty, the Probability of which will come next under our Conſideration.

As to the Spheroidical Figure of the Earth, How is that conſiſtent with a more neceſſary Principle of theirs, *viz.* The denying an Univerſal Fluid; for ſuch a Fluid I think is neceſſary in order to form a Spheroid. But ſuppoſe they urge, that God might have made it ſuch as well as a Sphere. It is true, this is poſſible, but not credible; for all the other Planets are ſpherical, notwithſtanding the Aſſertion of ſome, that *Jupiter* appears ſometimes oblong: But this wants to be confirmed by better Obſervations. *Venus* that moves round its Axis as ſwift as the Earth, is Spherical. As for Sir *Iſaac*'s Reaſon of the Pendulum's moving ſlower at the *Equator* than nearer the Poles, is very inconcluſive, becauſe other Reaſons can be aſſigned for that, much more probable than that the Pendulum is ſeventeen Miles farther from the Center of the Earth at the *Equator* than at the *Poles.* Such a Reaſon is given in my Account of Gravity, *viz.* That the oblique Direction of the Rays of the Sun did weaken the perpendicular Direction of the Vibrations that cauſed Gravity; and the Force of the Sun being greateſt at the *Equator*, occaſioned the Pendulum's moving ſlower there. So that I think I have better accounted for Gravity than by the occult Quality of Attraction to the Center of the Earth: But all Degrees of Latitude near the Poles are equal. If it be urged, that it is impoſſible to obſerve ſo minute a Difference, I am afraid ſo minute a Difference will not affect the Body of the Earth, ſo as to occaſion the Removal of the Equinoxial Points: But I do not take upon me to prove the Impoſſibility, but the Incredibility of it.

But let us go ſo far along with them, and allow the Earth to be a Spheroid, yet that will not do for the Removal of the Equinoxial Points. *Vid.* TAB. II. FIG. I. For ſuppoſe C D the Diameter of

the

the largeſt Plane of the Spheroid, when the Ring of the Spheroid comes to the Poſition C D, then it is more attracted by the Sun S, and haſtens to A; the Poize of the Globe being alter'd, and the whole a little twiſted. But why ſhould the Sun attract that part of the Globe at C more than at D? But to go along with them, let us ſuppoſe that too. Now the Poſition of C D coming to A B, and proceeding from B to E, the Attraction of the Sun retards the Motion; and being longer in that Courſe, muſt gain ſomething the contrary Way, and this little gained every Year, is transfer'd to the Stars, and they appear to move *in Conſequentia*. But if it ſhould be asked, why the retarding this Motion doth not ſtop at P, as well as the contrary Motion begin at C, or why C doth not begin to accelerate the Motion from E, as well as the retarding is continued to E, I believe a new Figure will ſcarce anſwer it: But N being the Center of Gravity, and dividing both Axes in the middle, the Action and Reaction of any Motion to the Sun muſt be equal, and ſo nothing gained in favour of removing the Equinoxial Points.

The Learned and Great Aſtronomer Dr. *Gregory* uſeth another Figure, ſomething like this, to explain this Difficulty. *Vid.* TAB. II. FIG. 2. The Ring or Protuberancy at the Equator *a b*, being more attracted by the Sun S in its Paſſage round the *Ecliptic* than the other Parts of the Earth, doth twiſt the Earth, and bring the Plane of the *Equator* ſooner than it ſhould to ſuch a Poſition, that if it were extended, it would paſs through the Sun, at which time muſt be the *Equinox*; ſuppoſe at the neareſt *Aries*, but the remaining Part of the *Ecliptic* being greater, the Earth by a contrary Attraction on the other Side of the ſaid Ring, muſt gain. But this falls under the Difficulties of the former Figure, and makes our Year leſs than a whole Circulation round the *Ecliptic*; and by this twiſting the Earth, alters the Paralaliſm of its Axis, and conſequently changes the Poles of the Celeſtial *Equator*, varies the Inclination of the Plane of the *Ecliptic* to the Plane of the *Equator*, and would make the Motions of the Fixed Stars not æquable when ſeen from the Earth, contrary to all Obſervations. For the Plane of the *Equator* cannot come to the Poſition neceſſary to make the *Equinox* in leſs Space than a full Semicircle without altering the Poſition of the Axis of the Earth.

Dr. *Gregory* mentions another Expedient, *viz.* That the Axis of the Earth deſcribes the Surface of a Cone. This fixes one of the Poles; but the Circulation of the other varies the whole Inclination of the Axis, and throws us into like Difficulties. Upon the whole, it is more probable that the Fixed Stars have their Revolutions, and the new Syſtem cannot make their Velocity credible. We are not to uſe too much Poetical Liberty in building Aſtronomy on improbable Gueſſes.

I ſhall next conſider the main Principles, the Foundation and Credibility of the New Syſtem. Its Principles are theſe; *viz.* That all Bodies gravitate to one another, eſpecially to the Sun, in a reciprocal duplicate Proportion of their Diſtances, if their Magnitudes be equal; if not, the Proportion of Matter contained in them to be likewiſe conſidered: That every Body that moves, endeavours to move in a ſtrait Line. Of theſe two compounded is the Circular Motion formed, and then they are termed *Centripetal* and *Centrifugal* Forces. That all the Heavenly Bodies move in an abſolute *Vacuum*; for any conceivable Reſiſtance would ſpoil the Syſtem. I ſhall only examine theſe at this Time. I muſt own the ſolid Orbs and afterwards the groſs Account which *Des Cartes* gives of his *Vortices* and Deferent Fluid: *Kepler*'s Images of the Sun, and *Leibnits*'s Account of his Deferent Fluid wanting either a preſiding Angel in the Sun, or ſome other Principle to keep his Univerſal Fluid from ſtagnating, made Sir *Iſaac*'s Principles very acceptable to the Learned World, as being much more conſiſtent than any before offered. They diſcover him to be a Gentleman of wonderful Invention and Strength of Genius, and of deep Learning and Capacity. Nor am I leſs ſenſible that my offering any Thing in Oppoſition will be conſtrued Ignorance and Vanity; but the meaneſt Genius may accidentally hit upon ſome Things that deſerve Examination, and at leaſt give the Favourers of Sir *Iſaac*'s Scheme an Opportunity to explain it better.

Theſe Principles do not look like Nature, that is, That one Body can attract another, or, which is the ſame thing, make it gravitate, without any *Medium* of Communication: Such blind Inſtinct is not to be allowed in Philoſophy. I think no Body gravitates but what is impelled, and I can have no Notion of Attraction in the ſtrict Senſe of the Word; and without an univerſal *Medium* or Fluid, *Centripetal* and *Centrifugal* Forces are but other Names for occult Qualities. Sir *Iſaac* thought it not impoſſible but that Gravity might proceed from a Fluid of great Elaſticity: Gravity is no intrinſic Quality of Bodies, more than Motion, both Affections proceeding from external Cauſes. And if ſuch a Fluid can be aſſigned as is a perpetual Mover of ſuch wonderful Velocity and Rarity, of a

Quality

Quality that Rubs and Frictions will not abate its Motion, of ſuch exceſſive Diſproportion betwixt this Fluid and other Motion in the Heavens, of ſurprizing Activity; we may well ſubſtitute this Fluid in the room of Gravity, of which it is likewiſe the Cauſe. This univerſal Fluid I call *Light*, the Name given it in the Holy Scripture. It is of the Nature of Fire, a ſmall Spark of which is eaſily kindled into a great Flame. The common Laws of Motion will not anſwer to ſolve the *Phænomena* of Fire and Light. It is reſtleſs and a perpetual Mover, the firſt Motion impreſſed by God on the Material World, and the Cauſe of all the wonderful Effects in Nature; the Vehicle of Light, ſo rare that it can give no conceivable Reſiſtance to the Motions of the Heavens. By the ſame Arguments Dr. *Gregory* endeavours to diſprove an Univerſal Fluid, I could prove that a Coal of Fire muſt be extinguiſhed by heaping Fuel on it, far from proving that by ſuch Rubs the Motion muſt increaſe: On the contrary, we find Reſiſtance will increaſe its Fury. A very ſmall Quantity of Powder, when kindled, no Art of Man can confine, and a Mountain above it but increaſeth its Violence. Fire, in the Bowels of the Earth, ſhakes it. Should we therefore ſuppoſe the univerſal Fluid to be of this Nature, what Frictions would abate its Motion? What therefore may not we believe of a much rarer Fluid, conſidering farther the immenſe Quantity of it, and the peculiar Motion of Light, *viz.* Its Vibrations to a Point, which Vibrations, when obſtructed, increaſe its Violence? There needs therefore new Laws and a new Theory for Fire and Light.

This Fluid being divided into Globular Vortexes, as God was pleaſed to order, vibrates from the Circumference of each Globe to the Center, and propels every ſluggiſh Particle to the *Nucleus* of it, and is in this manner the Cauſe of Gravity. The ſame Light keeps up a Communication betwixt the Heavenly Bodies, and is very receptable of oblique Directions. The ſame Globes of Light move circularly, each with a various and different Velocity. That there is Light is certain and unconteſted; but that there is any Gravitation to the Sun, is only a Gueſs, without any Grounds to ſupport it; no, rather we perceive a Force from the Sun. This Fluid will ſtand the Teſt of all their Objections. But not only are theſe Principles repugnant to Natural Philoſophy, but ſuch as I humbly conceive will not anſwer in Aſtronomy.

In general there is no accounting for the Elliptical Orbits of the Inferior Planets, eſpecially of *Mercury*, by theſe Principles. For tho' there may be an indefinite Number of Ellypſes from one immovable

movable *Focus*, with Variety of other *Focus's*, yet, where there is but one *Focus*, I cannot ſee that any *Ellypſis* can be formed from it. Now, there can be no other *Focus* aſſigned within the Orbit of *Mercury*; and without, no Aſpect of the Planets affects it. Nay farther, *Venus*, tho' farther from the Sun, hath not ſo long an *Ellypſe*. The like is to be obſerved among the other Planets, *viz.* That the Power of Gravitation to the Sun doth not regulate their *Ellypſes*. Dr. *Gregory* obſerves, that the Moon gravitates more to the Sun than to the Earth; and ſo it ſhould by the Laws of Gravitation: Yet it is Convex to the Sun, and Concave to the Earth, which is contrary to all the Laws of the New Syſtem.

Again, Their *Centripetal* and *Centrifugal* Forces are ſo multiplied, ſo various, and ſo contrary to one another, that they are incredible. The Diurnal Motion of the Earth, formed by a *Centripetal* Force to the Center, and a *Centrifugal* on the Tangent of the *Equator:* The annual Motion by a *Centripetal* Force to the Sun, and a *Centrifugal* on the Tangent of the *Ecliptic*, tho' the Sun is not in the Center of the Annual Orbit: nor can another *Focus* be aſſigned, to form an *Ellypſis*, within the Earth's Orbit; for *Venus* and *Mercury* in any Aſpect, do not affect the *Aphelium* or *Perihelion* of the Earth; neither doth the common Center of Gravity of the Sun and Earth anſwer this Difficulty: other ſtrange and contrary Forces to anſwer the Librations of the Earth; to regulate the Moon's Motions, more and new Forces muſt be invented, one to regulate the *Apſides* of the Orbit from Weſt to Eaſt, another for the Removal of the Nodes from Eaſt to Weſt, the contrary Way; ſuch contrary *Conatus's* are paſt Belief: But if the *Conatus* is increaſed or diminiſhed with the *Centripetal*, how, by theſe Principles, ſhall we account for the Long Trajectories of *Comets*, where the *Centripetal* Force is exceedingly diminiſhed? And yet the *Conatus* is not. So that the Projectile Force proceeds from other Cauſes.

The Inſtance they give of ſuch a *Conatus*, in a Sling whirl'd round, where the Stone goes off in a ſtrait Line, will not prove it: For if the Hand be ſuddenly ſtopped, as the Sling is let looſe, the Stone will fall not far off: They ſhould take care to diſtinguiſh betwixt Solids and Fluids. The Arms in a Wheel are ſtrait and rigid; the String extended in a Sling is alſo ſtrait, and the Stone thrown from the Sling muſt be in the ſame Direction as if it were thrown from the Hand, and follows its Direction. But if a String (as in Children's Tops which they throw out of their Hands) be wrap'd round the Top, and thus thrown on the Ground, will whirl round, and alſo move along the Ground in a Curve, not a ſtrait Line, without any Gravitation to the Center of the Motion. But this is more apparent in Fluids: for in ſtanding Water almoſt all Diſturbances raiſe Circular Motions, and are continued. In the Air, Whirlwinds are continued for a long time; and the more diſcontinued the Parts of any Fluid are, the more apt to circulate without Gravitation to the Center of the Motion. I muſt here add, that their Notion of Motion that will continue for ever in a *Vacuum*, if not ſtopped by an external Cauſe, is very unphiloſophical.

Did the Earth move round the *Ecliptic*, it would move very unlike the reſt of the Planets, who all have a Declination from it: Such an Orbit is fitter to be a Companion of the Fixed Stars. Altho' this is not concluſive, yet I think there is ſomething more in this, That the Motions of the Fixed Stars are all æquable, if ſeen from the Earth, which could not be if the Earth was a *Spheroid*, and the Sun have any Influence on it as to alter the Paralaliſm of its Axis: And unleſs they can make it better appear, that the *Magnus Orbis* is but a Point to the Heavens, than by ſuppoſing ſo, we may conclude that the Earth hath the beſt Title to the Center; at leaſt 'till another Syſtem can be found that will anſwer the *Phænomena* of the Planets.

It is pleaſant to hear ſome ſay, That the Force or Weight of one Atom more in the Projectile or gravitating Powers would inevitably put a Period to the Motions of the Heavens; and yet it is a true Concluſion from the New Principles: Whereas in *Ellypſes*, where there is but one *Focus*, the Projectile doth prevail, and in the Orbits of Comets; and there is no Planet but hath Excurſions, more or leſs. In ſuch Caſes, what is become of the ballancing Power.

The *Centrifugal* Force to turn the Sun round its Axis can no ways be accounted for by the New Principles: for the gravitating Power cannot exert itſelf in a Solid to draw the Parts of the Globe from a Strait Line into a Curve. There muſt be ſomething that moves circularly; ſuch as the Deferent Fluid I propoſe. Neither is there any need to fly to the Firſt, when Second Cauſes can be aſſigned for moving it round.

But nothing is worſe accounted for by the New Syſtem than the Theory of the Moon, I mean as to the Gravitating Principle: for their Obſervations and Calculations from the Properties of an *Ellypſis* are the Produce of great Genius's; but it is probable the *Ellypſes* are formed by other Forces. *Vid.* TAB. II. FIG. 3. In this Figure, by the New Principles, both Earth T and Moon L gravitating to the Sun S, they muſt either both be continued at an equal Diſtance at the Conjunction, or the Moon be more attracted proportionably nearer the Sun, as it is ſixty Semi-diameters of the Earth nearer; as alſo being leſs, muſt be more forcibly attracted: And at the Quadratures both Earth and Moon muſt draw nearer each other, as they draw nearer the Center. But if we ſuppoſe a repelling Force in the Sun, then it is plain they muſt draw nearer at the Conjunction and Oppoſition, and ſeparate at the Quadratures; elſe how is it conſiſtent that the Moon at the Conjunction being drawn nearer the Sun S, ſhould form a ſtraiter Line? It is true, the larger the Circle is, the leſs Curve is the *Perimeter*: But Lines drawn betwixt two Points, the nearer the Strait Line, the leſs curve they are. For this Reaſon the *Cycloid* A L B is leſs Curve than A D B. This is the Caſe of the Moon's paſſing from the Quadratures A and B, it is repelled by the Sun, into the *Cycloid* A L B, in which it will move ſwifter, and approach nearer the Earth. At the Oppoſition the Earth is forced nearer the Moon; for I do not ſuppoſe the Earth immovable, and at Quadratures, the ſame repelling Force muſt ſeparate them.

But farther, the new Principles ſtill account worſe for the Progreſs of the *Apſides* of the Moon *in Conſequentia*, and the Regreſs of the *Nodes*. As to the *Apogeon*, Mr. *Pemberton* acknowledgeth in his 8vo Edition, Page 145. That the Gravitation differs a little from the Recip. duplic. Prop. of the Diſtances; and Sir *Iſaac* ſuppoſeth the Velocity to the Sun to be near a tripl. recip. Prop. of the Diſtances in the Approach of the *Apogeum* to the Conjunction and Oppoſition, but leſs than a Duplicate in its Approach to the Quarters: But however, that the Increaſe exceeds the Decreaſe in a whole Circulation of the Moon, and conſequently the *Apogeum* muſt move *in Conſequentia*. In theſe there are many Suppoſitions, but little elſe: For, from whence ſhould the additional Force in Gravity proceed? They ſay, from the Earth: But by Dr. *Gregory*'s Figures, the Conjunction of both Gravitations is moſt from the Oppoſition to the laſt Quarter; but then the Syſtem makes the Power leſs. And from the laſt Quarter to the Conjunction, the Attraction from both Earth and Sun grows more oppoſite; ſo that at the Conjunction there remains no more but the Difference of their Gravitations. But ſtill to ſuppoſe the Increaſe to exceed the Decreaſe, is but begging the Queſtion: for the Diſtances are equal, and the Time longer which is allowed for the Decreaſe, *viz.* From the

Conjunction to the firſt Quarter, and from the Oppoſition to the laſt Quarter.

Now I beg leave to try how the repelling Power can ſolve this Difficulty, ſuppoſing a Deferent Fluid, *Vid.* FIG. 3. the Fluid as well as the Moon is preſſed towards the Earth. Now, according to Sir *Iſaac Newton*, the Force of the Sun on the Moon, if the Moon moved in a Circle *concentric* to the Earth, is nearly as $\frac{1}{70}$ of the *Radius*. The Fluid therefore that carries the Moon about, being preſſed on that Side next the Sun, in that *Ratio* forms in equal Times equal Areas to thoſe it would have formed were it not preſſed at all. And ſuppoſing theſe Areas to be comprehended under Triangles, the Baſes of ſuch equal Triangles are reciprocally as their Altitudes; which is as 69 to 70; therefore it ought to run $\frac{1}{70}$ faſter in this *Cycloid* than in a Semicircle. The *Apogeum* ſhould therefore be carried ſo much faſter round: But in the former Figure the Moon, or rather Fluid, is not equally preſſed the Length of the whole *Cycloid*, but in a Preſſure equal to the Half of it, *viz.* $\frac{1}{140}$. Now the $\frac{1}{140}$ of the whole Orbit is 2 Degrees 34 Minutes $\frac{2}{7}$ what the *Apogeum* runs in a Moon: But the true Courſe is 3 Degrees near 2 Minutes; but this Difference ariſeth from the *Excentricity* of the Orbit of the Moon and the *Ellyptical* Figure; as alſo from the Difference of the Influence of the Sun in the *Apſes*.

As to the Regreſs of the *Nodes*, Mr. *Pemberton*, altho' he gives us Sir *Iſaac*'s Scheme of it, yet owns, Page 135, That it cannot be accounted for by any Power directed towards the Sun: for no ſuch can give the Planet any Lateral Impulſe to direct it from the Plane of its Motion into a new Plane, but of Neceſſity muſt be derived from ſome other Center, where that Power is lodged, remains to be diſcovered: all the Demonſtrations from Gravity to this purpoſe are in vain: For truly one may judge that the Variation of the Force of Gravity was ſcarce ſufficient to produce the ſeveral *Phænomena* of the Moon in its proper Plane, and to anſwer the *Apogeum.* Sir *Iſaac* was obliged to alter the Proportion of its Acceleration. But to give it farther two ſeveral Directions, is too great a Load on that Principle.

But beſides the Moon being drawn out of its Plane by ſuch oblique *Centripetal* Force, I cannot ſee but it muſt long ago been drawn into the Plane of the *Elliptic:* For the ſame Force that could draw it out of its Plane, muſt have continued to do ſo, unleſs ſome Power can be aſſigned for reſtoring it.

Neither can I likewiſe conceive how the Moon can accompany the Earth in its very various Motions without a Communication, by ſome *Medium* for Gravitation, without an Impulſe, or varied *Conatus* or projectile Force, I look upon as no other than Inſtincts of Nature, and not to be aſſigned as Cauſes of the Heavenly Motion.

But to return to the Regreſs of the Nodes: Allowing a Circulating Fluid, and the Moon to be within the *Vortex* of the Earth, or at leaſt its Influence on the *Vortex* of the Moon: for this may be allowed to the Earth as well as to *Jupiter* or *Saturn*, who have peculiar *Vortexes* and Motions round them different from the general Circulation round the Sun.

Now the Moon moving in an Orbit, the Plane of which is inclined to the Plane of the *Ecliptic*, and both to the Plane of the *Equator*; (*Vid.* TAB. II. FIG. 4.) Now the *Vortex* of the Earth moving, as it is ſuppoſed, in the ſame manner, the Earth is turned round its Axis parallel to A B the *Equator*; and this Globe of Light moving with more Violence to the Center of the Earth in perpendicular Lines, while the Moon is propelled towards the Earth by the Sun being more within the Power of the Earth's *Vortex*, the Moon by theſe two oblique Directions muſt be drawn nearer the *Equator* and Center of the Earth, and conſequently meet the *Ecliptic* ſooner than it would otherwiſe have done. As this Preſſure abates, the Moon riſeth again, and performs the Remainder of its Orbit in the great Circle, which makes it meet with the *Ecliptic* in the oppoſite Node ſooner than the Moon before; ſo that the Moon moves in the Spiral Line, changing its Center *in Antecedentia*, 1 Degree, 20 Minutes each Moon.

There is another oblique Direction which may be aſſigned from the repelling Force of the Sun (*Vid.* TAB. II. FIG. 5.): For the Moon moving in a Plane oblique to the Plane of the *Ecliptic*, in which both Sun and Earth are, the propelling Force from the Sun forceth the Moon in an oblique Line from that which connects the Sun and Earth, and in a different Line from that, the Fluid in which the Moon ſwam before, and is driven towards the Earth. This Force being equal to $\frac{1}{10}$ of the *Radius* of the Moon's Orbit, will not place the Moon ſo near the Earth as the Fluid it ſwam in before; as in TAB. II. FIG. 6. For the Moon inſtead of being preſſed in the Line N D, is preſſed in the Line N I: So that inſtead of paſſing the *Ecliptic* at A, with the Fluid it croſſeth the *Ecliptic* at C.

The Indefinite Expanſion is unmeaſurable: However, I ſhall let paſs whatever Fancies Men may have of the Inviſible Part of the

World; Yet that the Viſible Stars are at no ſuch great Diſtance, I give the following Reaſons. It is obſervable, that the late Aſtronomers have ſtrongly magnified the Bulk and Diſtances of the Stars, and as much leſſened their apparent Bigneſs, or otherwiſe we could not make each Star a Sun, with his *Vortex* about it, eſpecially ſuch as are in the Milky Way, where the Suns are very thick ſet. About 60 Years ago they made the Sun at 128 Semi-diameters of the Earth from us; Now *Caſſini* and *Hugens* reckon 22,000. Stars in thoſe Days were but 2000 times as far off as the Sun, now *Syrius* is 27,000 times as far off: *Syrius*, by *Tycho*, was computed at 3 Minutes Diameter, by others 2 Minutes; and *Gallileo* but 5 Seconds; the Moderns allow it no apparent Diameter, only ſee it as a lucid Speck or Point. Glaſſes of 6 or 8 Feet give it a conſiderable Diameter; Glaſſes between 20 and 60 Feet ſee it with a Diameter 7 or 10 Seconds; but Glaſſes of 100 Feet ſee it as a Speck. This is ſtrange that Stars that appear of ſuch different Magnitudes to the Eye and through different Glaſſes of different Bulk, and in the longeſt Glaſſes of no Bulk at all. I do not doubt but at laſt by lengthening the Glaſſes they may reduce the Sun to a Speck too. Sir *Iſaac* tells us, that in the long Teleſcopes the *Radij* from the Fixed Stars, altho' they enter the Glaſs as good as parallel, yet the Difference of the Refrangibility of the Rays cauſeth that many are ſcattered and loſt, and none but ſuch as are neareſt the Center affect the Eye; and the longer the Tube, the more of ſuch Rays are loſt and reach not the *Focus*. It is very true, that the Glaring of the Light near the Body of the Star, may make it appear to the naked Eye larger than really it is: But if we look on a Star with a reflected Light from a Looking-glaſs, that glaring Light is eaſily diſtinguiſhed. Yet the Glaſſes that can cut off that weak Light may be improved to cut off more, even ſuch Light as is ſent from the Edges of a Globe; the Roundneſs of it cauſing that fewer Rays are tranſmitted to us, the farther from the Center.

That Teleſcopes do not leſſen the Diameters of the Sun and Moon, is, that their Light is briſk and not weak; but that long Teleſcopes do ſcatter and yet farther leſſen weak Light, was obſerved by the *French* Academy when the Great Comet appeared, 1680. For after the Head of the Comet diſappeared to the Eye, it was ſeen by Teleſcopes, by one of 4 Feet, Plain; but by one of 20 Feet, Confuſedly and Dimly. Nay the Tail of the Comet was ſeen by the naked Eye, long after it could not be ſeen through a Teleſcope. This ſeems a little odd, That the Tail and not the

Head ſhould be ſeen lateſt by the Eye, and the Head and not the Tail by the Glaſſes. By this we muſt not conclude the Eye was deceived in ſeeing the Tail, but that the Eye is fitter to ſee a faint Light, and takes into View a greater Scope of the Heavens. The Glaſſes in long Tubes prevent the glaring of other Light by hindering few or no Rays to enter, but what were directly ſent from the Object. Thus the Eye cannot ſee the Stars when the Sun ſhines becauſe a multitude of other Rays enter the Eye, and affect the Optic Nerve more vigorouſly than the Stars: But the ſame Eye in an Obſervatory can ſee the Stars at Noon-day. So that the great Benefit of Glaſſes is to admit none but proper Rays, and the longer the Tube, the fitter for this Purpoſe. The Tail of the Comet could not be ſeen through the Glaſſes, becauſe of the Paucity and Weakneſs of the Rays; nor the Head by the Eye, becauſe of the Smallneſs of it, and Rays from a great Scope of the Heavens confuſed it. Juſt as in the Twilight often we cannot diſcover a Star, which when once the Eye is directly fixed on, is plainly ſeen. The Twinkling of the Stars proceeds not from floating Atoms in the Air, but from the reciprocal Vibration of Light.

Some Moderns have allowed to *Syrius* an apparent Diameter of 5 Seconds, ſome of 7 Seconds, and ſome of 10 Seconds; and it is but reaſonable and moſt probable that there is a real Difference diſcernable in the apparent Diameters of the Fixed Stars, and that the long Glaſſes which make them all equal, muſt be faulty in this. And farther, I muſt ſay, that the Eye is fitter to repreſent the true Magnitude, if freed from the glaring Light; which the moſt ingenious Sir *Iſaac* was convinced of, and therefore propoſed reflecting Glaſſes to this purpoſe. But as to Teleſcopes, if the Object be near, they magnify, and if at a vaſt Diſtance they repreſent Objects too little, and will never anſwer to judge of the Magnitudes of the Stars.

I ſhall therefore look on the Opinion of thoſe who allow ſome Seconds for a Diameter to *Sirius*, and the more, that it is not credible that ſo vaſt a Space ſhould be vacant as is betwixt our *Vortex* and that of *Sirius*, *viz.* 27664 times the Diſtance of the Sun from us — at 7½ Seconds *Syrius* will be removed 256 times as far off as the Sun, ſuppoſing the Sun and *Sirius* of an equal Bigneſs: But if *Sirius* be leſs than the Sun, or the Diameter of *Syrius* be 2 or 3 Minutes, then all the new Syſtem muſt be overturn'd, and the Earth once again takes its place in or near the Center.

The new Stars that appear and diſappear, eſpecially that in the Neck of the *Whale*, muſt be by the New Hypotheſis one of the Fixed Stars: For no opaque Body can be ſeen at their ſuppoſed Diſtance by a reflected Light. Such likewiſe are thoſe Stars which ſometimes appear ſingle, ſometimes double. No tolerable Account can be given of this and of their ſeveral *Phaſes*, unleſs we allow the Motion of the Fixed Stars, at leaſt as to the Variation of their Longitude. If that Star in the Neck of the *Whale* doth circulate in an Orbit (as no other Hypotheſis will anſwer all the Appearances of it, particularly the different Magnitude it appears under in different Revolutions), the Orbit it moves in muſt be about the Bigneſs of the Solar Orbit, becauſe it wants $35\frac{1}{4}$ in its Revolution of a Year. Now, if the Diameter of its Orbit bears ſo conſiderable a Proportion to its Diſtance from us, why ſhould not a like Orbit, if the Earth moved round the Sun, repreſent other Stars that are far nearer to us, leſs or more, as we depart from or approach nearer them?

The *Ellypſis* of a Comet by the New Hypotheſis is incredible. How great muſt it be when the fartheſt *Focus* is not ſo near as 27664, the Diſtance of the Sun? To what *Focus* doth it gravitate? If they ſay an *Hyperbola* may have its Center or *Focus* beyond its *Vortex*, ſuppoſe the Sun; I own it is a ready way to get clear of all Difficulties to tell us it never returns, but goes off *in infinitum*, at leaſt as far as the Mundane Space extends, and there ranks itſelf in the fartheſt Space. But I know not what ſhould ſtop the projectile Force (by the new Hypotheſis) through an infinite *Vacuum*. But even in a *Parabola*, or ſuch a long *Ellypſe*, when the Comet deſcends near the Sun, where is the Force to draw it back, both againſt the projectile and gravitating Powers? If this be their Caſe there needs ſome new Force to perfect their Hypotheſis: Or, if all the Planets or Stars do gravitate to one another, why the Comet, paſſing the Way of ſo many of them, is not attracted by ſome of them; for it is not the Sun's being on fire that gives it an Attracting Quality, but a repelling.

Conſidering therefore the great Variety of contrary Motions, not two Planets moving in the ſame Plane; even the Rotation of the Sun varies from the *Ecliptic* $7\frac{1}{2}$ Degrees; neither hath the general Projectile the ſame Direction, but infinitely varied in one Circulation of a Planet. But in aſſigning an univerſal Fluid, which the Holy Scripture calls *Light*, as the Cauſe of the Heavenly Motions, is giving a more ſimple and general Cauſe: And if the Properties of ſuch a Fluid do anſwer, there is no need of ſubſtituting imaginary ones.

I think I may ſet down theſe Principles as the moſt probable ones, *viz.* That there is ſuch an exceeding ſubtle Fluid, of wonderful Activity, a perpetual Mover, which keeps up a Communication amongſt the Heavenly Bodies, the Vehicle of Light, the Cauſe of many ſurpriſing *Phænomena*, and no external Cauſe can be allowed for Gravity but the Activity of ſuch a Fluid, and therefore fitter to be aſſigned for the General Cauſe of the Heavenly Motions than Gravity.

The Objections againſt ſuch a Fluid are ſeveral: Some of them I ſhall now anſwer, the reſt in the following Sections. Sir *Iſaac's* are chiefly drawn from this, that the Sun communicates this Motion to the Fluid: Were it ſo, His and Dr. *Gregory's* Argument againſt it were unanſwerable: but ſo far from that, That it is the Fluid that communicates to the Sun what it hath. This Motion, ſo far from declining in the reciprocal duplicate *Ratio* of the Diſtance from the Sun, that it is the ſame in every Part of Light: That inconceivable quick Vibration of Light is inſeparable to the Nature of it. This it is that preſerves the Activity of the Fluid, and the other Motions of it. The Velocity of that Light which proceeds from the Sun and Stars, exceeds our Comprehenſion; but being oblique to the perpendicular Vibration of the Univerſal Fluid, weakens and decays: but the Perpendicular doth not, which, the farther it goes, the more violent it is, as may be ſeen in the Deſcent of heavy Bodies: For the Force of Light from the Stars is only adventitious and external, whereas the other is the natural and neceſſary Motion of the Fluid.

This it is that preſerves our Fluid from being obſtructed by Rubs and Frictions, which, the more it is reſiſted, the more violent it grows. And for the Gentlemen of the New Philoſophy pretending to endeavour to meaſure either the Time or Diſtance when it ſhould grow languid, is in vain; for there is no comprehenſible *Ratio* betwixt any Rub or other Motion can be given; and this of the pureſt Light.

Another Objection is from the Comets moving, ſome as it were from North to South, others from Eaſt to Weſt, contrary to the general Current of the reſt of the Heavens, that it is not to be imagined that ſuch Comets can be moved by a general Fluid; nay, that ſome of them ſeem to move in ſtrait Lines. But in Anſwer to this, the Theory of Comets is as yet little underſtood. However, in Swools of Water we may perceive ſome Parts of it go off to a great Diſtance one way from the Center, and almoſt in ſtrait Lines. Such vaſt Excurſions in ſome Eddies of Water ſhew that Comets can move in ſuch long Orbits, by the Nature of Fluids, without Gravitation, to the Center of the Whirl; and go off and return in Lines not very diſtant from Right ones, and may be meaſured by *Ellipſes*, or Part of their Orbits, by parabolic Curves, and may be ſeen unaccountable Interſections of Orbits; and the nearer the Center of all theſe, the ſwifter. And all this to be demonſtrated by the Preſſure and Current of the adjacent Fluid and other Incidents.

The Motion of Comets from Eaſt to Weſt, we ſee the ſame in ſeveral *Satellites*, ſome of which diſappear for near half of their Orbits: After all they may be only *Satellites* moving in Orbits convex to the Earth. As to Comets moving from North to South, we may obſerve the ſame in the outmoſt *Satellites* of *Saturn*, the Planets of every *Vortex* having different and peculiar Circulations, like Whirlpools in a River. A larger *Zodiac* will ſerve for other more common Comets: Neither is there any need to make them Fire, or to be inflamed by the Sun, to account for their Tails. Such a Light is ſeen in the North Part of the Atmoſphere of the Earth, which Northern Light is oppoſite to the Sun, a little declined, and cauſed by Cold and not by Heat.

Dr. *Gregory*'s Argument againſt ſuch a Fluid is from a Fluid's moving in the reciprocal duplicate Proportion of the Diſtances from the Center; but the Planets move in the Seſquipl. *Ratio*, therefore are not moved by a Fluid. In which I conceive he is miſtaken: For this *Ratio* is not peculiar to the Motions of Fluids, but different *Ratio's*, and the Seſquipl. and greater can be raiſed: For different Proportions are to be raiſed in the ſame Diſtances by different Velocities; ſo that when the Motion becomes placid and very ſlow, the Motes ſwimming in ſuch a Fluid circulate almoſt in equal times. I uſed a Veſſel exactly circular, and near half a Globe, and found as I moved my Hand in ſtirring the Water, ſo the Motes at firſt moved, but gradually inclining to the Shape of the Veſſel. This occaſioned many Alterations in their Orbits, the Orbits of ſome of them interſecting thoſe of others; and the Fluid was moved in like Sections of *Ellypſes* to the Bottom, as may be remarked by Bits of Brown Paper ſunk and ſinking in the Veſſel. Another Inſtance of Variety is by ſtriking a Table whereon ſuch a Veſſel is placed full of Water, which will raiſe a circular Wave moving ſwiftly from the Circumference to the Center, and as ſuddenly ending there. If all this Variety and more, without any Gravity to the Center of the Motion or Planes, can be raiſed by my weak Hand in ſo groſs a Liquid as Water, much hindered by Gravity, What may not we expect from an almoſt infinite rarer Fluid, moved by an Omnipotent Agent? Theſe Reaſons are ſtrong enough to prove that Fluids are ſufficient, at leaſt to prove that they are capable of a Variety of Motions; and that Planets moving in different Planes is no Argument againſt an Univerſal Fluid: And he may ſee moſt of his Objections anſwered by an Experiment on ſuch a Veſſel.

The Nature of Fluids, eſpecially of Fire or Light, if better underſtood, would help to form a more probable Syſtem of the World than has hitherto appeared: For they that advanced ſuch a Fluid only conſidered it as circulating, and neglected the other Properties of Fluids, ſuch as the Vibrations of Fire, and their Aptneſs for forming Celeſtial Bodies. Likewiſe the Whirlpools in Water, or Whirlwinds in the Air, which are carried round, the mean time the Whirlings float along the general Stream, or in the Air, contrary to the common Courſe of it: The Clouds are often driven oppoſitely. By this the Motion of the Planets in *Vortexes*, contrary to the General Current, may be accounted for.

All the Planets have different Declinations from the *Ecliptic*: This it is likely may ariſe from a Compound *Ratio* of the Velocities of their particular *Vortexes*, and the Inclination of the *Axes* of ſuch particular Planets to the Plane of the *Ecliptic*. It is plain, *Jupiter*, which moves ſwifteſt round its Axis, hath the greateſt Declination; and that *Mars*, which differs little in Velocity from the Earth, declines little from the *Ecliptic*. What farther Difference there is betwixt *Mars*, *Venus*, and *Saturn*, may be occaſioned by the diverſe Inclinations of their *Axes*; like a Ship, whoſe oblique Poſition of its Rudder in the Water moves it acroſs the Stream. *Venus* is likewiſe ſwifter than the Earth, and hath a greater Declination.

Beſides the *Ellypſis* peculiar to each Planet, ariſing either from the Nature of Fluids, or ſome other unknown Cauſe, there is another movable *Ellypſis* accompanies the Sun, by its repelling Force. This is plainly viſible in the Moon, where always the ſhorteſt Diameter is at the Conjunction, the Orbit of the Moon being convex to the Sun: But in *Mars*, where the Orbit is Concave to the Sun, the longeſt Diameter is at the Conjunction. Gravitation does not afford ſuch ſatisfactory Grounds for the Solution of this as may be given from a Repelling Force.

The Syſtem therefore that I think leaſt liable to the *Incredible*, and not built ſo entirely upon Fancy, is, That the Earth is near the Center, and moves in a ſmall Circle by the repelling Force of the Sun, as in TAB. II. FIG. 5. not ſo great as to place the Fixed Stars at ſo vaſt a Diſtance, and yet to anſwer for the Retrogade Motions of the Planets. For I ſee no Reaſons to induce me to believe, That any one Body ſhould be immovable in ſuch a Fluid; neither is this ſtrange to the New Hypotheſis which makes the Sun and Earth to move round a common Center; or that the Earth moves round its Axis, which takes away the incredible Velocity of the Heavens.

Conſequently the Sun moves round the Earth in the Ecliptic; that its repelling Force ſerves inſtead of a *Focus* to the *Ellypſes* of the Planets, and that the *Apſides* of the movable *Ellypſes*, when it hits with the true one, places the Planet yet farther from the Earth, and is the Cauſe of their various Elongations; and thus the Sun very much rules the Planets.

Thus alſo the Earth is a ſecond *Focus* to the *Ellypſes* of the Superior Planets, which, by the New Syſtem, we cannot find. By this may be underſtood why the *Ellipſis* of *Mars* is ſo long, if we make the Earth the Center; becauſe this Planet is more forcibly repelled by the Sun, the Orbit of *Mars* approaching ſo near the Way of the Sun. The Sun's repelling Force is the Cauſe of many Irregularities in the Courſes of the Planets.

There is one Objection yet remaining againſt all I have ſaid, which is, That if the Fixed Stars move in a Fluid round the Earth or Center, long e'er this they would have varied much in Longitude: But this ſuppoſeth the Fixed Stars to differ much in Diſtance from us. But ſhould I allow *Ptolomey's* Hypotheſis which placeth them all at an equal Diſtance, this Objection is anſwered.

But I hardly think this probable: For there are good Reaſons to believe them at unequal Diſtances; yet in that Caſe, we are not to reckon that the General Fluid moves by the ſame *Ratio* with the Solar Syſtem, which as a *Vortex* in the general Stream, hath its peculiar Motion, *viz.* in the Seſquip. *Ratio*. The General Fluid is more placid, and all the Stars may move thus in equal Times; or if not altogether in equal Times, yet may vary ſo little that as yet their Difference in Longitude may not be diſcernable. Neither can we allow them all of an equal Magnitude, nor ſo great a Diſtance among them as the New Hypotheſis ſuppoſeth. An Inſtance of which is the new Star in the Neck of the Whale, which ſometimes appears larger than one of the ſecond Magnitude, at other times of the third, and by degrees vaniſheth; and all this in leſs than the Compaſs of a Year. Now it cannot be imagined, that the Diſtances betwixt the Stars can be ſo extravagant, when one in ſo ſhort a time can paſs through ſuch Diſtances, and return. Beſides, allowing the Sun and Stars of equal Sizes, yet that their Diſtances are in proportion to their apparent Diameters, will not hold: For Globular Light, afar off, grows weak at the Extremities of the Diameter, and ſoon diſappear; ſo that their Diameters leſſen much faſter than their Diſtance increaſeth.

FINIS.

☞ *Page* 64. *Line* 4. *for* FIG. 5. *read* FIG. 7.

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